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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

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THE CLOSING OF THE EXPOSITION.

The great exposition which has been open to the world for the past seven months closed its gates on the first day of this month. It has been predicted frequently that this would be the last great general exposition, and that any others which may be held in the future will be limited to some one industry.

Since the Centennial Exposition, in 1876, when the exhibition of the telephone attracted so much attention, electricity has played an increasing part in these affairs. In the one just closed it was a more important agent than any other. It contributed not only to the pleasure and comfort of the visitors, but was, as well, an important factor in the management of the exposition affairs. Those who were particularly interested in the electrical arts found there a magnificent display, while features appealing to the popular interest were not lacking. Bearing in mind what has been predicted as regards future expositions, it is confidently expected by many that the next one will be electrical. The stupendous growth of the electrical industries, and the extension of electrical methods into other fields, support this view.

To Professor W. E. Goldsborough, chief of the department of electricity, and his able assistants we extend our felicitation on the success with which the electrical features were planned and carried out.

ELECTRIC HARDENING OF HIGH-SPEED TOOL STEEL.

Three electrical methods of hardening tools intended for high-speed cutting were described in a paper by Mr. J. M. Gledhill, read before the Iron and Steel Institute at its recent meeting. The methods are old, but the application is new and promises to become important in the machine-shop.

The first process is an adaptation of the old so-called water-pail forge. The tool, held in a suitable clip, is connected to one pole of a dynamo. The cutting end is introduced into a solution of sodium carbonate held in a vessel which forms the other electrode. A heavy current is passed through, which is controlled by the rheostat in the field of the dynamo. The tip of the tool is quickly brought to a high temperature. When the proper point has been reached, the circuit is opened, the solution instantly chilling the steel. In another method an arc is struck between the tool to be hardened and a carbon electrode, the former acting as the positive electrode. The intensity of the arc is controlled by a rheostat in the dynamo field, as before. This method is very rapid, and allows the heating to be localized, as desired. In the third method the metal to be heated forms part of the secondary circuit of a transformer, and is thus heated by the heavy currents set up in it. This method is particularly convenient when it is desired to temper such forms of tools as milling, gear and other similar cutters. It may also be used when large, hollow taps and reamers, or other hollow tools made of high-speed steel are to be rendered soft and tenacious internally, without detracting from the hardness of the cutting edge. In this method the tool whose temper is to be drawn is mounted on a mandrel, which itself is inserted in the secondary of the transformer. By regulating the current through the primary of the transformer, the temperature to which the tool is brought is controlled, and it can be allowed to cool at any desired rate.

The only objection made to these methods is the cost of the apparatus. This, however, should not be serious, when the convenience and accuracy of the methods are borne in mind. The heat can be applied instantly, and the temperature is always under control. There is no danger of chemical action on the steel, and the energy required is small, since the apparatus is in use but a short time and there is no waste while idle. The methods proposed should find ready application in those machine shops where there is already an adequate supply of electric power, in a form suitable for this work.

CAUTION NECESSARY WHEN EMPLOYING PRODUCER GAS.

The gas engine, because of its high thermal efficiency, is becoming an exceedingly important factor in the development of the electrical industries. It was not, therefore, in a spirit of hostility that we called attention to certain dangers existing

when this gas is employed, but in the hope that these dangers might be provided for and accidents thereby avoided. The source of danger has been referred to before, but it may not be amiss to reiterate it. Illuminating gas causes death by asphyxiation, since respiration can not be sustained in it. It is true a small percentage of carbon monoxide is contained in this gas, but it is not the cause of death. On the other hand, producer gas contains a large percentage of carbon monoxide, which is decidedly poisonous, so that this gas is far more deadly than one which merely does not supply the requisite amount of oxygen for breathing. It is essential, therefore, to take every precaution against leakage when producer gas is employed, and this is the more necessary since it does not always make itself known. A man may breathe it without being aware of it until his faculties are so benumbed that he does not realize his condition.

This matter is referred to again at this time because of a recent fatal accident in Wales. At a certain ironworks, where producer gas was used for firing the boilers, it became necessary to close down one boiler for cleaning. This was done, and two men were directed to clean the flues. The result was that both were killed by gas which found its way into the boiler which was being cleaned from the others which were being fired. Exact details of how the accident occurred are not at hand, but that it was possible proves that the precautions which should have been taken were not observed. The gas may have found its way back through the flues past a damper, or it may even have percolated through the brickwork. It did not warn the men of its presence, and they, unfortunately, were probably so placed that the other men about the plant did not observe their condition until too late. Every engineer of a plant where producer gas is used should realize fully the dangers incident to the handling of this gas. He should also impress upon his employés the necessity for observing all precautions; but, above all, he should see to it that his plant is so arranged and constructed as to make the risk as small as possible. The use of gas for firing boilers and for operating gas engines is increasing every day, and there is all the more need for laying stress upon the care which should attend its production and use.

One frequently comes across news items announcing wonderful discoveries in which electricity plays an important part. A recent announcement of this character is to the effect that the electrical action of the life principle in the living organism has been successfully demonstrated. This might mean much or nothing at all, depending upon the knowledge of the reader. It appears to be difficult for the layman to realize that electricity shows itself as a form of energy, and that it may be produced from other forms of energy if conditions are favorable. This is particularly true of chemical reactions. It is also probably true of actions taking place in living organisms, but it does not follow that the electrical energy developed plays any more important part in the life of the organization than heat. Chemical action may take place in which energy is liberated only in the form of heat. On the other hand, in an electric battery by far the greater part of the energy set free appears as electrical energy, although the chemical reaction in the two cases is identical. Is it not probable that the case presented by a living organism is similar, and the electrical effects produced are merely secondary, and not essential?

ELECTRIC RAILROADING.

The time seems ripe for sober speculation as to the development of electric railroading in a broad sense. This branch of electric engineering has been steadily growing along two distinct lines. One of these is based upon enlargements and extensions of the system common to the handling of street traffic. The other has as surely, but less prominently to the public mind, been the outgrowth of a recognition which large steam railroad corporations have given to electricity and its probable ultimate value as a potent force in the operation of the special if not the ordinary sections of their systems.

At present the attention of the electrical fraternity is turned in a large degree towards the electric railroading problems now being worked out. It is impossible for one to take a trip of one hundred and fifty miles or more through the central west on the fine interurban roads there operated without quickly coming to a realization of the possibilities of electric railroading which the future holds. An inspection of the new terminals in the city of Indianapolis, with their fine facilities for handling passengers and express matter, immediately impresses one with the simplicity of the new system. Cars are constantly arriving and departing over nine different electric interurban roads for cities and towns in all directions within a radius of one hundred miles of Indianapolis, and the striking thing about it all is that the work is carried on without any confusion, and in a commonplace way that hardly excites the notice of the passing public. These interurban roads operate to an exact time schedule with but few exceptions, and the train service varies from hourly to half hourly departures at the terminal points.

It is well worth the time of any engineer making a trip westward to stop at Indianapolis and observe how successfully and smoothly the interurban electric railway problem is being handled.

But this phase of electric railway work must share its prominence in engineering with the work being inaugurated by the New York Central Railroad. The tests which were officially conducted at Schenectady but recently show with what a fine degree of precision and certainty heavy steam railroad traffic can be handled electrically. The enthusiasm which an important project, successfully completed, always generates will not, in the present instance, be lost or fail to make an impress upon the thinking men, whether engineers or financiers, who are responsible for the conduct of the large railway properties. And furthermore, as no one is quicker to appreciate the fine points of a new machine than men who have linked their lives' work with machinery—we doubt not but that the engine drivers and train crews operating the present steam railway systems will welcome the advent of the electric locomotive for long-

haulage work as enthusiastically as they now welcome a new example of the modern high-speed steam locomotive.

It is hard to imagine a more successful outcome to the tests at Schenectady than that which has been chronicled in the press, and the commission having this work in charge is deserving of our most hearty congratulations. It now seems certain that the work of electrifying the Pennsylvania terminals and of carrying other projected work involving the use of electricity in the movement of heavy trains will proceed with the same success that has attended the inauguration of electric traffic on the elevated railways of New York city, and as will undoubtedly attend the placing of the New York Central locomotives in active operation between Croton and the Grand Central station.

THE FUTURE OF THE STEAM LOCOMOTIVE.

Recent tests of large electric locomotives have set the daily press to wondering what will be the effect of this new development upon the steam locomotive. The value represented by the locomotives in use to-day has been figured out, and the amount is so large as to raise doubts about the probability of any great amount of transformation taking place. The New York *Evening Post* asked a railroad president, whose name is not mentioned, what will become of the steam locomotives now in use if it can be shown that operating expenses can be reduced by using electricity as a motive power? The reply was as follows: "A glance at the cost of the one item of fuel in the recently issued annual statements is enough to interest any railway official in any question promising cheaper motive power, but the problem of substituting electricity for steam has not passed the experimental stage yet, even for local or suburban business. In any event, the locomotives now used will not be hauled to the scrap pile. Some way will be found, if necessary, to convert them from steam into electric locomotives. That is what happened on some of the western roads where oil was substituted for coal and water."

This comparison is hardly satisfactory. The locomotive built to burn coal can be adapted to the use of oil without any great difficulty, but it is difficult to see what part of the steam locomotive could be retained with advantage in reconstructing it for electrical operation. The tender would, of course, be dropped completely; next, the boiler would go, and the engine proper—that is to say, the two sets of cylinders with their connecting rods. Next, the driving wheels would be discarded, because they are too large to be used with advantage with electric motors, which will naturally make a greater number of revolutions per minute than the old wheels were designed for, and, besides, the driving wheels of the electric locomotive should be perfectly balanced—another reason for discarding the steam drivers. The truck of the steam locomotive would hardly be suitable for an electric locomotive, and it would probably be cheaper to throw away the old cab and build another. This leaves us only the cow-catcher, the sand-box, the couplings, the bell and the whistle, but the latter would be discarded as inefficient. Sifting matters down thus, we see that there are several parts of the steam locomotive which might be retained and used in building an electric locomotive, but they are hardly of sufficient importance to count much. What will happen, most probably, if the steam roads turn to electric traction will be this: certain sections, where conditions are suitable, will be electrified first, and the steam locomotives thus set free will be distributed over other sections of the road, replacing those which have been worn out. The electrical zone will only be extended gradually, so that even the newest steam locomotives will probably see many years of active service—at least, on some part of the road. As a matter of fact, no one expects to see all the locomotive works of this country thrown out of business within the next year or so.

THE TRANSFORMATION PRODUCTS OF RADIUM.

The brilliant work conducted by Professor E. Rutherford, of McGill University, in the new and important field of radioactivity attracted attention in the scientific world about a year ago. Professor Rutherford showed that radioactivity could be explained by assuming the disintegration of the radium atom, and that, during this disintegration or degradation to a less complex form, there were certain stages or steps in the transformation which appeared to correspond to definite forms of matter in an unstable condition. Radioactive phenomena, according to this theory, are caused by the successive breaking up of these different states. It will be remembered that three types of rays have been identified, which, for convenience, have been designated as α, β and γ. The different stages are themselves identified by the character of the radiation which is set up during disintegration. The different stages which have heretofore been recognized in the disintegration of radium have been designated, first as the emanation, which represents the product formed by the breaking up of the radium atom itself. This emanation, in turn, breaks up, forming the three other stages designated as radium A, radium B and radium C. By further, persistent, careful work, Professor Rutherford has identified two more stages, which he designates as radium D and radium E, and it is thought that further investigation will bring to light more stages in the change from radium to helium.

In the *Philosophical Magazine* for November, an account is given of his recent work, the most important discoveries being the identification of the radio-lead of Hoffmann, and polonium, discovered by Mme. Curie, as the two new products. Their properties are predicted as follows: radium D, which is apparently the same as radio-lead, changes to the next form twenty-five times as rapidly as radium, and during this change the β-rays—that is to say, electrons only—are emitted; and hence, measured by this radiation, it should be, weight for weight, twenty-five times as active as radium itself. Radium E, or polonium, has a life of only one year, while that of radium is 1,000 years, and, weight for weight, the former should be 1,000 times as active, measured by the α radiation which it gives off only.

This identification of the two previously discovered substances as two stages in the disintegration of radium is very important, as it simplifies the science; but it will be most surprising if we find that there is, after all, but one substance having marked radioactive properties.

Presidential Address of Mr. Alexander Siemens to the British Institution of Electrical Engineers.

Mr. Alexander Siemens, the new president of the British Institution of Electrical Engineers, made his presidential address on the evening of November 10, 1904. In it he discussed the relations of capital and labor, the metric system, and the new British patent law. He said, in part:

The causes which influence the growth of industries, and therefore the rise of institutions connected with them, will bear further discussion, as they are of the most varied character and are an apt illustration of the interdependence of all factors of modern civilization. Considering the features of this civilization generally, it will be acknowledged, after a short reflection, that its true foundation is the lowering of cost of production. In other words, the progress of civilization is in proportion to the cheapening of the articles of consumption. Although this may sound purely materialistic, the process of lowering the cost of production —which implies the employment of all the knowledge we can acquire, and of all the training the best schools can give us—results in greater ease of acquiring the necessaries for keeping alive, and therefore it gives us more time to cultivate other aspects of our existence. This general principle has manifested itself as much in the electrical industry as elsewhere, and further progress appears to be dependent on further lowering of the cost of its products. When we come to enquire into the means for carrying out this principle, we soon recognize that the solution of the problem depends upon a variety of circumstances, which all influence the result, although they may be investigated and discussed separately. For "internal working"—if I may say so—every industry depends upon three principal factors—first, capital, which provides the works and the raw material; second, the workman, who converts the raw material into the finished product; third, the management.

It is quite idle to try to establish the relative importance of these three factors, for each one is indispensable, and likewise, the prosperity of each one is inseparable from the prosperity of the others, so that no industrial establishment can flourish where these three factors do not cooperate harmoniously. As a first condition for further progress we should, in fact, recognize the identity of interests between the capitalist, the workman and the management, as any measure which is intended to unduly favor any one of these three factors would inevitably increase the cost of the product beyond what it ought to be, and thereby restrict its sale, thus damaging all three. When we examine in detail in what way each of the three factors can contribute to the lowering of the cost of production, we find ample confirmation of the intricacy of the problem. The share of capital in the value of the finished article is proportional to: (*a*) the cost, depreciation and maintenance of the works and their outfits; (*b*) the cost of the raw materials; (*c*) the profit, representing the interest on the total capital invested in the undertaking.

In order to minimize the first item the works ought to be carefully planned and equipped so as to be careful of turning out the maximum quantity of produce, and their machinery should be selected and laid out in such a way that its wear and tear is only due to its legitimate working, and that the handling of all materials is reduced to a minimum. The second item —the cost of raw materials—is too intimately connected with fiscal questions for treatment in this address.

There is apparently not much difficulty in diminishing the third item—the profit on the capital invested; but it stands to reason that the interest earned on the capital could not fall below a certain amount without the industry in question losing the support of capitalists and collapsing. The rate of interest may, therefore, be considered a fixed quantity, and in order to diminish the amount payable under this head it is important to avoid burdening an undertaking with more capital than is required for setting it up as a going concern and for providing a reasonable amount of working capital.

When considering the influence of the second factor—the workman—on the value of the product, it becomes clear very soon that the amount of work turned out in a given time has a twofold influence on the result, as the time occupied in producing an article not only regulates the amount of the wages, but also the proportion of the dead charges to be debited to the article. It is, therefore, quite certain that, in order to contribute his share to the lowering of cost of production of an article, the workman has to turn out a greater number of these articles in a given time; and the problem is, how to attain this object without endangering the interest of any one of the three principal factors. This sounds almost as if slave labor would prove an economic plan in the carrying on of industries. It can, however, hardly be contended that the interest of the workman is considered under such conditions, and for this reason alone it should be condemned, even if there were no other objections to it. There are, however, legitimate ways in which the amount of wages to be charged against an article can be diminished. The most important among them is the substitution of machine work for hand labor, and where this is done unskilled labor should be utilized for running the machines, under the supervision of a few skilled artisans. Here, again, the interests of the workman appear to suffer. Whenever he is confronted with a new labor-saving machine he airs his old grievance that machines will deprive the workman of his living, just in the same way as he opposed the use of all machinery a hundred years ago. The lesson taught by experience has evidently not made an impression; but nobody can deny that, instead of making skilled labor superfluous, the introduction of machinery has resulted in more skilled workmen being employed, and at better wages than before, and similar developments are likely to follow when the workman is further relieved from hard work by his best friend, the labor-saving machine. Another feature of machine work is the greater accuracy that can be attained, so that, while the cost of production is lowered, the quality of the product is improved; and, at the same time, interchangeability of parts is secured, which, in itself, contributes to the lowering of cost.

Restricting the output has nowadays exactly the opposite effect to that intended. When the price of an article is raised, owing to this supposed remedy, a number of consumers begin to do without it and the demand for it diminishes, so that less people can be employed on its production. Instead, therefore, of securing employment for more men, it will endanger the continuance of work for those who restrict the output under the mistaken impression that they are benefiting their fellow-workers. Workmen also have a rooted objection to seeing machines worked by unskilled men, which is apparently based on the mistaken notion that such unskilled men are replacing skilled workers. They, however, overlook the fact that labor-saving machines are only introduced where the same articles, produced by hand labor, would be too expensive for sale; consequently no skilled workmen could be employed. Another fetish of the workman is the desire that all workers should be treated alike and no preference shown, absolutely ignoring

the fact that the capable and industrious are more deserving than the lazy and careless workers.

However important capital and labor are to an industry, the third factor—management—is none the less essential for its satisfactory progress. In this term is included: (*a*) the selection of site for works, their planning and their equipment; (*b*) the commercial work connected with the business; (*c*) the arrangements for carrying on operations; (*d*) the designing of new apparatus and the investigation of new methods of manufacture. It is easy to understand that in every one of these directions good management can do much to lower the cost of production, but this is hardly the time to discuss all these points in detail. Only on the last I venture to make a few remarks, as proper design is a matter in which the members of this institution are interested, more particularly those who have only recently graduated from a college. Good design should have for its aim the lowering of the cost by employing simple, component parts, which can easily be obtained or cheaply manufactured. The first requirement is fulfilled by utilizing standard sizes; and in this respect the work of the Engineering Standards Committee is of the greatest possible importance to the industries of this country. In addition to these standards much can be done to facilitate working by adhering to standard parts in each factory, so that it is not necessary to carry an immense variety of parts in stock. The designer should have an intimate acquaintance with the scientific principles that come into play, and with the ways in which they are applied, and he should know, if possible, from personal experience, the capabilities and limitations of the workmen and the machinery by which operations are carried out. It is, however, by no means sufficient for preparing suitable designs to be well acquainted with the means employed to execute them. It is just as important to form an accurate conception of the problem that is to be solved and to possess a thorough knowledge of previous attempts in the same direction, and of the causes of their success or failure. Another branch of knowledge required for the good management of factories is careful training in the way of conducting experimental investigations, coupled with a good judgment as to which investigations are worth taking up. No doubt the list of qualities that ought to be found in a good manager could be expanded still further, but enough has been said about the three principal factors to show the points which have to be considered in the development and working of modern industries.

Besides these internal factors there are all the extraordinary circumstances which influence the well-being of the industries, and it is easy to see, even without entering at length into further details, that no true picture of the state of an industry can be arrived at if only a few features of its complicated constitution are to be taken into consideration. These remarks about industries in general apply naturally to the young electrical industry quite as much as to the oldest established one. There are, however, some features of its development which have greatly contributed to its rapid rise, and could, perhaps, be imitated in other industries to their great advantage. At first the long time when weak battery currents alone were employed—chiefly for telegraphic purposes—permitted the completion of important scientific investigations which, in the end, led to the discovery of those fundamental laws which form the basis of all practical applications of electricity. Nor did science desert the industry when it began to deal with powerful currents. I will only remind you of Mr. Hopkinson's mathematical demonstration in this room, that alternating-current machines can be worked in parallel. This example is particularly interesting, as in this case science has pointed out to the engineer how he could solve one of his problems. Usually the function of science has been to prevent its followers from being deceived by appearances of plausible fallacies. By such negative indications alone science can give definite answers, while its deductions of a positive character can not be accepted without further proof, owing to the uncertainty of whether all premises necessary for the correct solution of the problem have been taken into consideration. For this reason, deductions arrived at theoretically should be tested by practical application before further conclusions are based upon them. Here, again, the electrical industry has had a great advantage in possessing from its very beginning most sensitive instruments which, in addition, are easily handled, so that the verification of theories has been a comparatively easy matter, and it has been possible to control, by accurate measurements, all operations, not only in the laboratory, but also in the workshop.

One feature of electrical measurements has contributed more than anything else to the rapid rise of the industry, and that is the adopting of the same units of measurement in all countries. Certainly, there is no doubt about the beneficial effect of the adoption of this system (the metric system) by all countries, and I have no recollection of ever hearing that the decimal division adopted by it has ever given rise to any difficulties. It is true that some modifications have become necessary, which were discussed and accepted at a series of international congresses called for the purpose; but, so far as I am aware, nobody has ever suggested that it would be to the advantage of any country to start a system of electrical units of its own. In spite of these favorable experiences, we know that there exists an obstinate resistance to the general adoption of the metric system in this country, although it has been shown, over and over again, that the reasons for this obstruction are based on fallacies, and are opposed to the experiences of other countries. Such an attitude is very largely due to want of practice with a thoroughly consistent system of weights and measures.

Among other external factors which influence the technical side of industries are the patent laws of the various countries—a subject of which the most divergent opinions have been pronounced. It would lead me too far if I attempted to discuss all the features connected with the patenting of inventions, but I should like to direct your attention to the fallacy of considering a preliminary examination—as practised in the United States, for instance—to be of any advantage to an inventor. That system of examination involves as much trouble and expense as a lawsuit, but it is no bar to a lawsuit being commenced later on, and then the same case has to be argued over again. A favorable result of such an examination is, therefore, in no way a guarantee of the validity of the patent. It is, however, the business of an inventor to find out for himself what has been done before, and to make himself thoroughly acquainted with the subject before he begins to suggest improvements. In this work he should be assisted by the staff of the patent office, or a library for technical subjects should be at his disposal, containing not only patents, industrial designs, or models and trade-marks, but also files of the principal technical and scientific transactions and periodicals. Searching such records will prove to be a liberal education, and will, in the end, be of greater advantage to the inventor than having this work done for him by the members of the staff, who can not be as well qualified to make the search as the inventor himself, as their acquaintance with the essentials of such a new device is necessarily inferior to his.

GROUNDED TRANSMISSION MEDIUMS—II.

BY J. STANLEY RICHMOND.

EARTH POTENTIAL MEASUREMENTS.

As mentioned in an earlier article, it is necessary for convenience to sometimes use in the consideration of electrical phenomena, besides absolute and arbitrary zeros, two others designated self-zero and medial zero; self-zero being that of the voltage of the point having the lowest voltage and medial zero that of the voltage of the middle point electrically in a generating and transmission medium.

Fig. 1 is a diagrammatic representation of a so-called insulated transmission medium. In practice, however, such insulation is not obtainable; for, at some point or other of the circuit, a lesser or greater ground exists. And it is due to the fact that such ground with direct-current transmission is one day at one point and another day at another point that the expression arose that "one day our system is positive and another day it is negative." It must be understood, of course, whether the system is running "negative" or "positive," that the direction of transmission remains the same.

Fig. 2 similarly represents a generating and transmission medium, but with the low-voltage side of the generating medium grounded. As a result, the voltage conditions can be illustrated as shown in Fig. 3, in which BE being the zero line, E is the voltage of the pole B, A is the voltage of the pole A, and AE is the varying voltage of the transmission medium. The arbitrary zero and the self-zero of this circuit will be that of the voltage of the pole B.

Fig. 4 illustrates, diagrammatically, similar apparatus; A being grounded instead of B, when the voltage conditions will have to be represented as in Fig. 5; in which AE being the zero line, E is the voltage of the pole A, B is the voltage of the pole B, and BE the varying voltage of the transmission medium. The arbitrary zero of this circuit will be that of the voltage of A; while the self-zero will be that of the voltage of B.

Fig. 6 also diagrammatically illustrates similar apparatus, but with C (the medial point electrically between the two poles) earthed, when the voltage conditions will have to be represented as in Fig. 7; in which CE being the zero line, A is the voltage of the pole A, B is the voltage of the pole B, AE is the varying voltage of one-half of the transmission medium and BE the varying voltage of the other half of it. The arbitrary zero and the medial zero, in this case, will be that of the voltage of C; while the self-zero will be that of the voltage of B.

The writer is inclined to assume that electrical condition is the attraction existing between the molecules of which matter is composed. Voltage, therefore, may be

FIG. 1.—INSULATED TRANSMISSION MEDIUM.

described as the degree of such attraction and must not be confused with potential, which is the ability to do work due to the difference between two voltages. Potential and not voltage, therefore, is the "cause" producing any "effect" designated an electrical phenomenon.

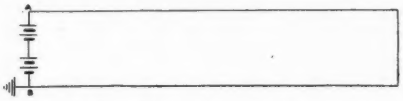


FIG. 2.—LOW-VOLTAGE SIDE GROUNDED.

Incidentally, it may be stated that a so-called voltmeter is incorrectly termed. Correctly speaking, it should be termed a potential meter. For it does not measure voltage in respect to a standard zero, but only the difference in voltage between (or

FIG. 3.—VOLTAGE CONDITIONS.

potential of) two points, the one on one body and the other on another body, or between two different points of one body.

To illustrate, in a minor way, the practical application of the zero question, take the case of special potential meters de-

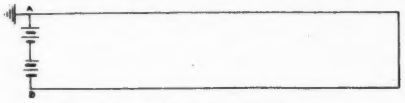


FIG. 4.—"A" SIDE GROUNDED.

signed by the writer for the measurement of earth potentials.

Fig. 8 is a sketch showing the arrangement of the scale for a single centre-zero potential meter having two ranges of five and fifty volts, respectively. As

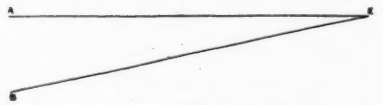


FIG. 5.—VOLTAGE CONDITIONS.

will be noticed, the words "Above" and "Below" are used instead of the usual signs + and —, and that the centre of the scale is marked "Zero." The binding-post, usually marked + on a centre-zero instrument, is, in this case, marked "Zero." To take, with such meters, the potentials between the rails of a surface street railway and the hydrants with a view to tabulating the voltages of the hydrants, the *Modus operandi* is as follows:

Each instrument with two insulated cords, one long and the other short, is accompanied by two boys; the elder of which handles the meter and hydrant connection, while the younger one takes charge of the rail connection. The elder one is also provided with printed forms, a facsimile of which is marked Fig. 9, and is instructed to be very careful to keep his end of the longer cord always attached to the "Zero" post of the meter throughout the whole set of readings, while the younger boy holds the other end of it on to the near-by rail, which he has previously cleaned. The shorter cord, which is attached to one of the two other binding-posts (according to which of the two ranges is being used), is connected to the hydrant by the elder boy, who is instructed to read the deflections just the same as he would the variations of temperature indicated by a thermometer: that is, if the deflection of the needle is above the zero the reading is entered on his form without any sign; and, if the deflection of the needle is below the zero, the reading is entered with the sign — before it. If the deflections of the needle are both below and above the zero at the same place they are entered (to use arbitrary figures) as — 2.50 to 3.25. To assist in the prevention of mistakes, it should be impressed on the reader that he should always read and enter from a lower reading to a higher reading.

Fig. 10 is a reproduction of a photograph of a duplex potential meter (two instruments like that before described but with the scales graduated for millivolt readings), also designed by the writer. The lid was removed while the photograph was being taken so that the special arrangements would show up better. Duplex voltmeters, similarly constructed, are used for comparative work—comparison of the voltages of two bodies with that of the voltage of a third one used as the zero. Take the case when investigations are taking place in regard to a surface road, an elevated road and cable sheaths (all earthed). First: the surface road rails can be connected to the two zero posts, while the other post of each side of the instrument is connected, respectively, to the elevated structure and the cable sheaths. A second set of readings can then be taken with the zero posts attached to the elevated structural work, while one of the posts on each side

of the instrument is connected, respectively, to the rails and sheaths. The wiring of these duplex instruments is such that the needles move in similar directions and equally under similar influencing conditions. The comparative results are very interesting and instructive.

Such explanations are rather long; but,

FIG. 6.—MEDIAL POINT GROUNDED.

in practice, it is remarkable with what rapidity and accuracy boys can take these readings, even if they have no electrical knowledge.

As a practical illustration of the foregoing method of taking potential readings and the method of analysis afterward

FIG. 7.—VOLTAGE CONDITIONS.

adopted, take the case of one investigation made by the writer in a district where of two systems (one an elevated and the other an overhead trolley) only the trolley was being electrically operated. Investigations were carried out in reference to two conditions of operation; which two conditions are diagrammatically represented, the one in Fig. 11 and the other in Fig. 12. When the street rails had no load on them for some distance away from the elevated structural ironwork, that is, when the nearest carload was as in Fig. 11, the structural ironwork was about five volts above the voltage of the street rails in proximity to it; or, *vice versa*, the street rails were about five volts below the voltage of the adjacent structural ironwork. The grounded portions of the two systems at this point had, therefore, a potential of five volts. When the carload was on the street rails close by the structural ironwork, however, as shown in Fig. 12, the structural ironwork was only about one volt above the voltage of the contiguous street rails; or, *vice versa*, the street rails were then about one volt below the voltage of the structural ironwork. The grounded portions of the two systems, therefore, had, under this changed condition of carload, a potential of only one volt. The lesser potential at this point indicated, therefore, the transmission of a much greater amount of energy by the grounded returns than the higher potential—which is explainable, for the voltage of the trolley wire of the street-railway system was several hundred volts above the voltage of the street rails; and when a considerable amount of energy was being transmitted from the trolley wire through the cars to the street rails, the latter, as a result, were raised in voltage; that is, the voltage of the street rails near the structural ironwork were raised from — 5 to — 1. The zero which was used in this case—an assumed one—was that of the voltage of the structural ironwork at the point where the investigations were carried out.

Several cases have also come under the writer's observation where of the two returns (during operation) the street rails had the higher voltage. As a result, the partial balancing, equalizing or reversing of the comparative voltages of the elevated structural work and the street rails appeared to result when the elevated trains were passing, so that the potential nearly always increased as the distance of the elevated trains from the point of investigation increased. Care has to be exercised, therefore, in concluding, in such a case, that a gradually increasing potential is due to the gradual cutting out of resistances by the elevated motorman at the controller; that is, an increasing potential between elevated structural work and street rails is due, in such case, to a decreasing elevated load at the point of measurement.

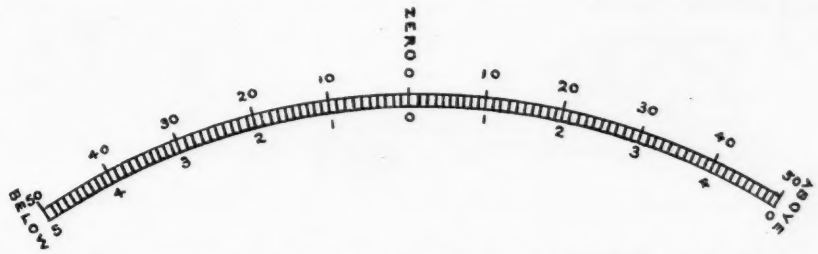


FIG. 8.—ARRANGEMENT OF SCALE FOR SINGLE CENTRE-ZERO POTENTIAL METER.

EARTH POTENTIAL READINGS.

When potential readings are taken, care should be used that the deflections of the needle of the potential meter (voltmeter) do not mislead one; due either to imperfect connections at the terminal leads or through the failure to fully consider the $C = \frac{E}{R}$ law analytically.

As an example of imperfect connections, take the case of a poor conductor or insulating material such as a cement pavement. Naturally enough, if the terminal leads are simply laid on the cement at two different points, the contacts made are bad ones. To make good connections in a case like this, a liberal amount of water should be poured on the cement at the points between which the readings are to be taken; and two tinpails weighted with water and with the terminal leads attached to them should then be placed on these watered points, one pail on one point and the other pail on the other point.

As explanatory of an analytical consideration of the $C = \frac{E}{R}$ law, take the case of the complaint made to the writer by a railway company that the men handling the installation of its bare cables intended as auxiliaries to its third rail, which was in service at the time, were receiving severe shocks.

POTENTIALS BETWEEN HYDRANTS AND RAILS.
(FIGURES GIVEN ARE VOLTAGES OF THE HYDRANTS TO THE RAILS.)

*Readings taken by*_____
*Date*_____
*Weather*_____
*Preceding Weather*_____ *for*_____ *Days*_____

READING NO.	LOCALITY.	TIME.	VOLTS.	REMARKS.
		TO	TO	
		TO	TO	
		TO	TO	

FIG. 9.—PRINTED FORM FOR MAKING RECORDS OF FALL OF POTENTIAL TESTS.

Fig. 13 is a sketch illustrating in cross-section the arrangement of its bare auxiliaries and third and traction rails.

On examination, it was found that the inconvenience to the men only resulted

when these bare cables were insulated (not grounded). A thorough investigation gave the following results:

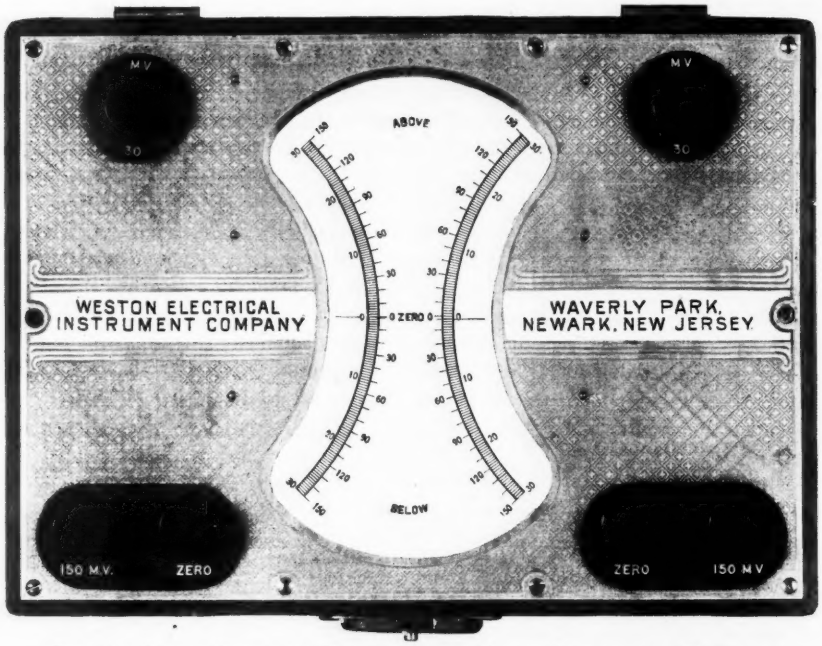


FIG. 10.—DUPLEX POTENTIAL METER USED IN MAKING ELECTROLYTIC SURVEYS.

Contact, by means of the hands to these bare cables and the traction rails, did, at times, cause unpleasant sensations of such magnitude as to be conclusive to one experienced to such that a considerable potential, much greater than that shown by a potential meter, existed.

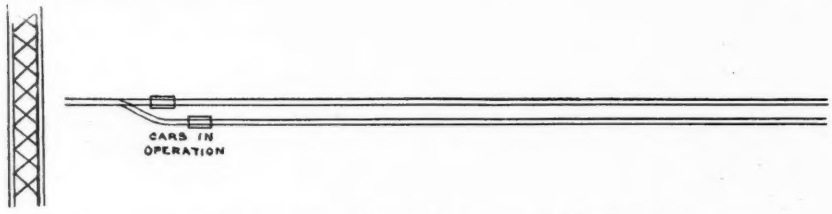


FIG. 11.—STREET RAILS WITH LOAD NEAR TO THE STRUCTURAL IRONWORK.

The sensations were only experienced by making and breaking contact. They were, therefore, not due to alternating potential.

As the sensations were not due to alternating potential, they were not the result of induction caused by the few volt variations of the voltage of the third rail.

As the shocks were rapidly experienced if making and breaking were carried out rapidly, such could not be due to the discharge of inductance (induced charge), as in the case of a so-called static condenser.

When readings were taken with a potential meter, the lineal deflections of the needle were the same whether the low or high range terminals of the instrument were used. Such unexpected action of the meter, however, is explainable, because voltage is only one of the factors necessary to produce a deflection of the needle; for it simply forces the amperage through the resistance. So that $C = \frac{E}{R}$ is only true when the amount of C is sufficient. In Fig. 14, consider the meter as having two ranges: the resistance coil of the lower one having with the resistance coil of the movable coil a resistance of 2,000 ohms; and the higher range having, similarly, a resistance of 10,000 ohms. That the voltage of the third rail is 555. That the traction rails have a voltage of five (five volts drop). That the insulation resistance between the third rail and the bare auxiliaries is four-tenths of a megohm. That the insulation resistance between the bare auxiliaries and the traction rails is a little over one megohm. That, of course, the third and traction rails are connected to a generating medium. The voltage of the bare auxiliaries will then be 400.

Now by $C = \frac{E}{R}$, the 2,000-ohm resistance requires for a true deflection $\frac{400}{2{,}000} = \frac{200}{1{,}000}$ amperes, or 200 milliamperes. But when the meter is connected to the bare cables and the traction rails, the total resistance controlling the C is 2,000 + 400,000 ohms; which, by $C = \frac{E}{R}$, permits of the transmission of only $\frac{400}{402{,}000} = \frac{1}{1{,}005}$ amperes, or, roughly, one milliampere. But it has been shown that 200 milliamperes are needed for a true deflection under the condition of potential existing. As a result, only one-two-hundredth of a true deflection will be obtained. That is, the meter, instead of showing a potential of 400 on the lower range of the scale, will only show one of two.

Similarly, the 10,000-ohm resistance requires for a true deflection $\frac{400}{10{,}000} = \frac{40}{1{,}000}$ amperes, or 40 milliamperes. But

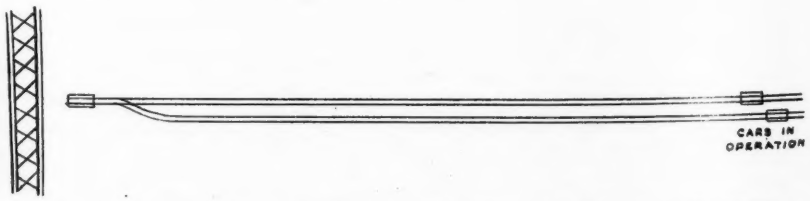


FIG. 12.—STREET RAILS WITH LOAD SOME DISTANCE FROM STRUCTURAL IRONWORK.

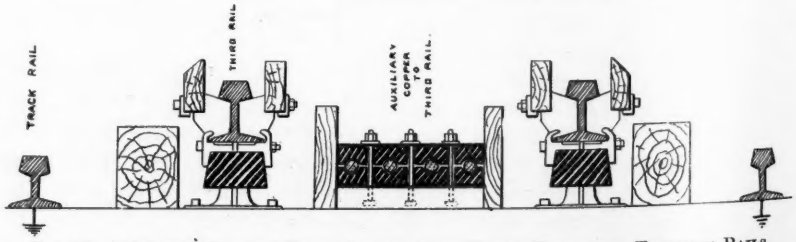


FIG. 13.—ARRANGEMENT OF BARE AUXILIARIES, THIRD RAILS AND TRACTION RAILS.

the total resistance governing the amount of C transmitted is 10,000 + 400,000

ohms; which amount of C, therefore, is $\frac{400}{410{,}000} = \frac{1}{1.025}$ amperes, or, roughly, one milliampere. But, in this case, it was shown that forty milliamperes are required to produce a true deflection. As a result, only one-fortieth of a true deflection will be obtained. That is, instead of a high range showing a potential of 400, it will only show one of ten.

Now two volts potential by the lower range and ten volts potential by the

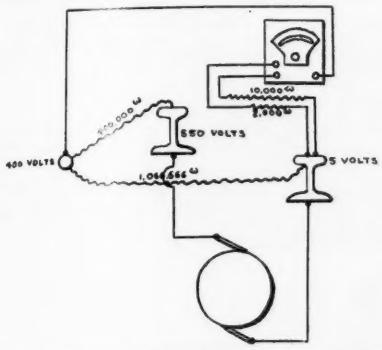


FIG. 14.—METER CONNECTION FOR TESTING TRACK DROPS.

higher range are read by a deflection of the needle to the same point on the scale. That is, the lineal deflection of the needle of a potential meter, in cases similar to that under consideration, will always be the same whether the low or high range terminals are used. And in somewhat similar cases, where very small potentials are dealt with, as in many instances occur when taking the potential of earthed conductors, the deflections, owing to the small amount of C available, will be so slight as to be unreadable. Many cases have come under the writer's observation where, having obtained a potential of, say, one-quarter of a volt between one earthed conductor and an earthed return and two volts between another earthed conductor and the same return, he has been unable to obtain readings showing a potential between the two earthed conductors; though, as will be understood, there must be one of one and three-quarters volts.

Fuel-Testing Plant of the United States Geological Survey.

In a recent circular issued by the United States Geological Survey, Department of the Interior, Washington, there is described the fuel-testing plant which has been erected at the World's Fair, St. Louis, Mo. All of the apparatus in the plant has been donated free of charge. The circular also details the tests which have been, and which are to be, conducted at this plant.

The Dangers of Producer Gas.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

In your last issue you reprint an article from some foreign paper, upon the dangers attending the use of producer gas. The statements therein are perhaps correct as to pressure producers used in very large plants, but the article entirely overlooks the suction producer, which is now coming into very extensive use for powers under about 300 horse-power.

We are driving our machine shop with a seventy-five-horse-power Nash engine and an R. D. Wood Company suction producer. There is never at any time even the slightest trace of the gas in the engine room. There are leaks, we know, in the producer and piping, but as there is always a partial vacuum, due to the suction of the engine, these leaks simply allow air to enter.

When the engine is not running, the gas valve is thrown over and all gas passes off through the chimney, just like a common stove. We do not see how the gas is so very dangerous, for though it contains a very large proportion of the deadly carbon monoxide, it also contains a large amount of sulphur that gives it a most disagreeable odor.

With the producer plant we are saving about $8 a day over the old steam plant, and we can not understand why this system is not in extensive use in electric light service.

No skilled attention is required and no regular engineer, and when properly installed the apparatus is fully as reliable as steam, and there is an entire freedom from danger of explosions.

We find that we are burning about one and one-quarter pounds of pea anthracite per horse-power-hour. We utilize nearly all the hot-jacket water in the works, and in the winter we turn the exhaust gases through a small heater that supplies enough steam to warm the shop, except in very cold weather, and thus the total thermal efficiency of the plant is very nearly one hundred per cent.

S. W. RUSHMORE.

Plainfield, N. J., November 18.

Indian National Congress Industrial Exhibition.

The Indian National Congress Industrial Exhibition will be held in Bombay, India, in December, 1904. The Victoria Jubilee Institute, Bombay, India, is making an effort to have on file copies of the various industrial and scientific publications of the United States.

BOOK REVIEWS.

"Fowler's Electrical Engineers' Year Book," for 1905. Manchester, England. Scientific Publishing Company. Leatherette. 589 pages. 4 by 6 inches. Supplied by the ELECTRICAL REVIEW at 75 cents.

The 1905 edition of Fowler's Electrical Engineers' Year Book is the fifth issue of this little handbook. Since the first issue this book has increased in size by 100 pages, in spite of careful elimination. It contains a complete directory of electric lighting and power stations in the United Kingdom. In this edition a substantial increase has been made in several sections dealing with the types and use of electrical measuring instruments. Some notes are given upon the management of dynamos and operating dynamos in parallel. The recommendations of the British Standards Committee for generators and motors have been embodied in this issue. The treatment of alternating currents has been increased, while additions have been made to the subject of electric traction.

"Private House Lighting," by Frederick H. Taylor. Percival Marshall & Company. 26 to 29 Poppins Court, Fleet street, London, E. C. Boards, 130 pages, 5 by 7¼ inches, 68 illustrations. Supplied by the ELECTRICAL REVIEW at 50 cents.

This book is not intended to be a text book for engineers, but it is for the information of those who, though not necessarily electrically trained, wish to gain an intelligent and accurate idea of modern practice of electric lighting in private houses. It describes the various systems of wiring, giving rules for size of conductors, the arrangements of circuits, lights, switches, etc. A chapter is devoted to the proper testing of a completed installation. Accessories used in wiring a house are described and illustrated profusely. The cost of installation and the cost of using electric light are taken up in separate chapters. The last chapter of the book is devoted to the descriptions of various types of generating plants for private houses. The book is written in a simple style, well suited to the non-technical reader.

The *Four Track News* for December partakes a great deal of the holiday spirit. There are the usual contributions from the editor on the world's progress, setting forth the drift of the time. The "Vest Pocket Confidences" is enlarged, and the illustrated little histories contain memorials on "The State Coach of Charles X," "A Unique Memorial," and "Fulton's Folly." An interesting illustrated article is on "Distinguished Alumni," by E. B. Borst.

New Power Plant at Sheffield, England.

By Emile Guarini.

THIS very interesting power station is built on a site affording exceptionally favorable facilities for the supply of coal and water, being situated between the river Don and the main line of the Great Central Railway. The northern end of the site is occupied by the first portion of the station which has just been completed.

The coal and ash plant is a very complete one. The coal is discharged from the railway trucks or trimmed from the store directly into the steel coal chutes, which are fitted with breeches pipes and measuring chambers, through which the coal falls by a gravity into the stoker hoppers. By an arrangement of valves each charge is automatically measured, and the amount of coal registered on counters. The ashes from the boilers are wheeled out in dumping cars, running in a tunnel below the firing plates, and deposited upon a grid covering the elevator hopper. They are then lifted by the elevator into a storage chamber from which carts or trucks can be loaded. This elevator consists of a series of buckets carried by an endless steel chain, the buckets overlapping each other to prevent the chemical and mechanical action of the ashes destroying, by their contact, the steel chain. The apparatus is driven by a seven-horse-power, two-phase motor, with speed-reducing gear.

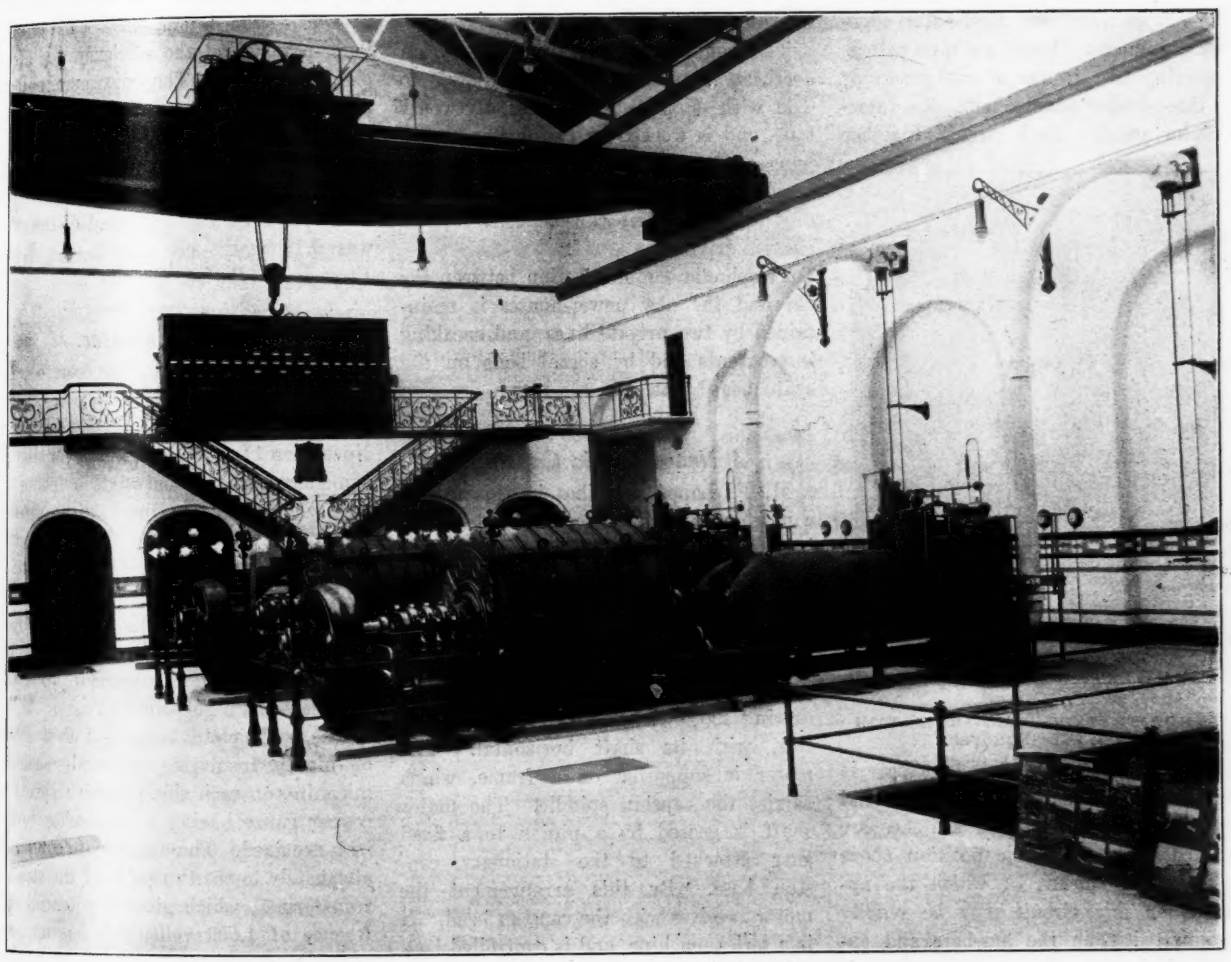
Two Stirling boilers are at present installed. Each boiler has 6,210 square feet of heating surface and eighty square feet of grate area, and is fitted with a Stirling type of superheater capable of dealing with the full output of steam, which at full load is 30,000 pounds per hour. Each boiler is fitted with Bennis's patent quadruple machine stokers and compressed air-furnaces, each arranged with strong cast-iron side-bars and seven compressed air-bars complete with grids. The front of the bars is carried on strong iron strechers and rollers, the back-ends being supported on a substantial cast-iron bearer; and the backs of the furnaces are sealed with brickwork carried on a cast-iron bridge, below which is fixed a cleaning-out door. The driving of the stokers is effected by means of two three and one-half horse-power, two-phase electric motors per boiler, through countershafting by means of rawhide belts. Each boiler is also fitted with its own induced draught apparatus on the Ellis & Eaves system, with the air-heating apparatus patented by the chief engineer. Each boiler is finally provided with a Sturtevant fan capable of discharging 45,000 cubic feet of air per minute when running at a speed of 580 revolutions per minute, against a water pressure of two and one-fourth inches. The fans are driven by two two-phase, thirty-five-horse-power motors running at 580 revolutions per minute. Three feed pumps of the Worthington long-stroke, vertical, double-acting type have been supplied, two of which are

THE NEW POWER PLANT AT SHEFFIELD, ENGLAND—EXTERIOR VIEW.

capable of feeding the four boilers at their full output, one pump acting as a spare. The whole of the steam piping is wrought steel, lap-welded with cast-steel T-pieces, the valves being the Hopkinson parallel slide type in cast-steel, fitted with Platnam seats, having to work with superheated steam. The whole of the steam piping is covered with non-conducting asbestos compound. All pipes are carried on roller brackets or sling supports where expansion is to be anticipated.

The alternators are two-phase, have four poles, fixed magnets and revolving armatures. The magnets are of circular pattern, the coils being mounted on laminated pole-pieces projecting radially inwards. The armatures are of the tunnel-wound type, the windings being led through holes drilled below the surface of the core in a direction parallel to the axis of the armature shaft.

The exciters are of the ordinary type, and, as stated above, are coupled direct to the alternators. The exhaust steam from the turbines is taken to surface condensers in the basement. The tubes are of hard-drawn brass, supported in the usual way by sagging-plates. The water chamber at the end of the condenser is so arranged that the covers may be removed, and the tubes examined or withdrawn without disturbing any pipe connections. The cooling surface of the tubes in each condenser is about 2,000 square feet, and the metal is 18 Birmingham wire gauge, and three-fourths inch external diameter; they are fitted into tube plates with tape-packed glands at each end. Baffle plates are provided where necessary. The circulating water inlet is at the bottom of the water chamber, and the outlet at the top. Each condensing plant is provided with an eleven-inch Gwynne-type centrifugal pump coupled direct to a thirty-horse-power two-phase motor running at 750 revolutions per minute. The pump has an eighteen-inch diameter gun-metal disc, and is capable of passing about 150,000 gallons of water per hour. The air pumps are Parsons vertical compound type, three-throw, running at 100 revolutions per minute. Each pump is driven by an eleven-horse-power, two-phase motor, running at 500 revolutions per minute.



THE NEW POWER PLANT AT SHEFFIELD, ENGLAND—INTERIOR VIEW OF ENGINE ROOM.

The prime movers are two 1,500-kilowatt steam turbo-alternators, each with direct-coupled exciter, and fitted with mechanical governors for regulating the speed, also with safety governors for entirely cutting off the steam supply in the event of the speed becoming excessively high, due to accident or other cause. The turbines are bladed for running condensing, and are arranged for a working steam pressure of 190 pounds per square inch at the stop valves. The steam will usually be superheated about 150 degrees Fahrenheit, the temperature of the steam being 535 degrees Fahrenheit.

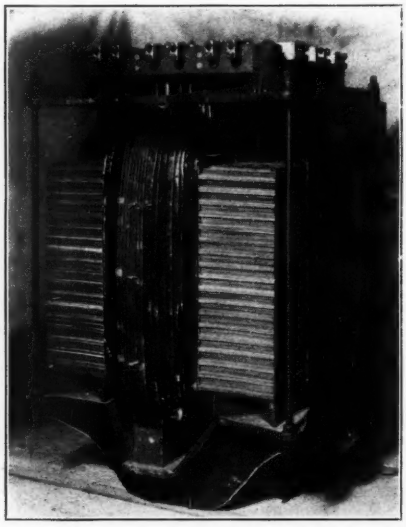
Oil coolers are erected in the basement below the turbines through which the lubricating oil for the turbines is passed, and cooled by means of cold water. This water is obtained from the condensers, and, after passing through the coolers, is led into the circulating discharge pipe.

On entering the engine room the steam pipes are fitted with stop valves and three-inch by-passes for warming up. The valves are arranged with extended spindles and handwheels, so that they can be

worked from the engine-room floor. The steam pipes are led to capacious separators close to the turbines, the connections from the separators including expansion pieces.

A motor-generator set of fifty kilowatts, consisting of a continuous-current generator of 100 to 140 volts at 750 revolutions per minute, is coupled direct to a two-phase induction motor of fifty cycles and 200 volts.

The high-tension switchboard consists of panels of enameled slate mounted in steel framework, and equipped with automatic oil switches and horizontal edgewise instruments. There are nine panels, there being two groups of one generator and three-feeder panels, with one interconnector panel. Each circuit, together



500-Kilowatt Static Transformer, with Outer Case Removed.

with all apparatus connected in the same, is separated from its neighbors by substantial barriers of slate. Isolating switches are provided in an accessible position above the board, by means of which the apparatus on any circuit may be readily disconnected from the bus-bars and entirely isolated. The automatic oil switches will open on predetermined overloads, and on emergency will safely open the maximum load that can occur on short-circuit. The high-tension apparatus is arranged in the simplest and safest manner by the use of series transformers for exciting all instruments and automatic attachments, which are by this means isolated from the high-tension circuit. All apparatus on the front of the panels is at low tension and connected to earth circuits, entirely removing danger of shock, and all high-tension apparatus within reach at the back of the panels is totally enclosed.

The trunk feeders consist of two pairs of five-square-inch concentric cables working at a pressure of 2,000 volts, the distance between the two stations being about two miles. These cables, which are drawn into four-inch cast-iron pipes, are of the well-known diatrine paper lead-covered type. The energy required for running the auxiliaries and lighting the station is transformed to 200 volts for the motors and 100 volts for the lighting by five transformers, which are fed through variable boosters. The station lighting is provided for by thirty-one arc lamps and 149 incandescent lamps.

The engine room is traversed by an overhead traveler crane constructed to deal with daily working loads of twenty tons, and is worked by cotton hand-ropes hanging to within one foot of the floor level. This crane is designed so that at any future date it can be converted to electric driving.

Telephonic communication between the old and the new power-houses is maintained by two private lines, and speaking instruments and by signal bells on the switchboard platform.

A New Electric Capstan.

M. F. Loppé describes in this article a new design of electric capstan, discussing the advantages of this method of driving. For this work the electric motor is well adapted, since it is easily controlled and particularly since it gives an excellent starting effort. The capstan head is placed on a vertical spindle, while the driving motor is placed vertically below this, with its shaft horizontal. The motor is supported on a frame, which carries the capstan spindle. The motor shaft is geared by a pinion to a fixed gear attached to the stationary capstan base. By this arrangement the motor revolves with the capstan head. It is a series machine, and is controlled by a cylindrical switch operated by a pedal. The first downward motion of this pedal starts the motor at its lowest speed. By successive depressions of the pedal, four additional speeds are obtained. Upon releasing the pedal the current is interrupted, and the motor immediately stops. To prevent meddling when the capstan is not in use, the pedal is turned sideways, and is then thrown out of action. Tests of this equipment showed the following results: when the tractive effort was 400 kilogrammes, the speed of the cord was 0.34 metre per second. The useful power corresponding to this is 1.83 horse-power. At this load the motor consumed 11.4 amperes at 220 volts, corresponding to 3.41 electrical horse-power. The efficiency is then fifty-four per cent. The efficiency of the motor alone is sixty-three per cent, and the mechanical efficiency of the capstan is eighty-six per cent. At this load the motor was running at a speed of 178 revolutions per minute, the speed of the capstan head being 1.54 revolutions per second. Characteristic curves of this equipment show that a maximum efficiency is obtained when the tractive effort is about 200 kilogrammes, the speed of the cord being one-half metre per second. At this load the power absorbed was 2.4 horse-power, and the efficiency was fifty-eight per cent. The maximum output of the equipment was obtained when the tractive effort was 850 kilogrammes, the power being 2.2 horse-power. At this load the total efficiency had fallen to thirty-seven per cent, and the speed of the cord was 0.18 metre per second.—*La Revue Electrique (Paris), October 25.*

Ozone Generator.

A new ozone generator has been recently brought out in London, and is described in the *Electrical Review*, of that city, for November 11. The apparatus consists of a mahogany box about sixteen inches by twenty-eight inches, lined with asbestos board. At one end is a small electric fan, producing the necessary circulation of air. Several baffle plates are placed within the box, on which the ozonizing grids are fixed. The box also contains a small step-up transformer for producing the necessary high potential.

The baffle plates consist of thin sheets of highly insulating material, such as micanite, on each side of which sheets of copper gauze having forty meshes to the inch are fixed. These sheets are connected alternately to the two poles of the step-up transformer, which gives a potential difference of 4,500 volts, this having been found by experiment to be the best pressure for the purpose. The ozonizing surfaces have an area of about four square feet. As at each corner of each mesh of the gauze the wire is necessarily bent so as to form an elevation, which may be regarded as a rounded point, there are 230,400 such points to a square foot of the ozonizing surface, giving a total of over 900,000 points in the apparatus, from each of which a discharge takes place. Owing to this extreme subdivision of the discharge there is said to be no sparking and no formation of nitrous compounds.

It is said that this apparatus is capable of ozonizing 30,000 cubic feet of air per hour, with an expenditure of sixty watts, including all the losses.

PROBLEMS OF HEAVY ELECTRIC TRACTION.[1]

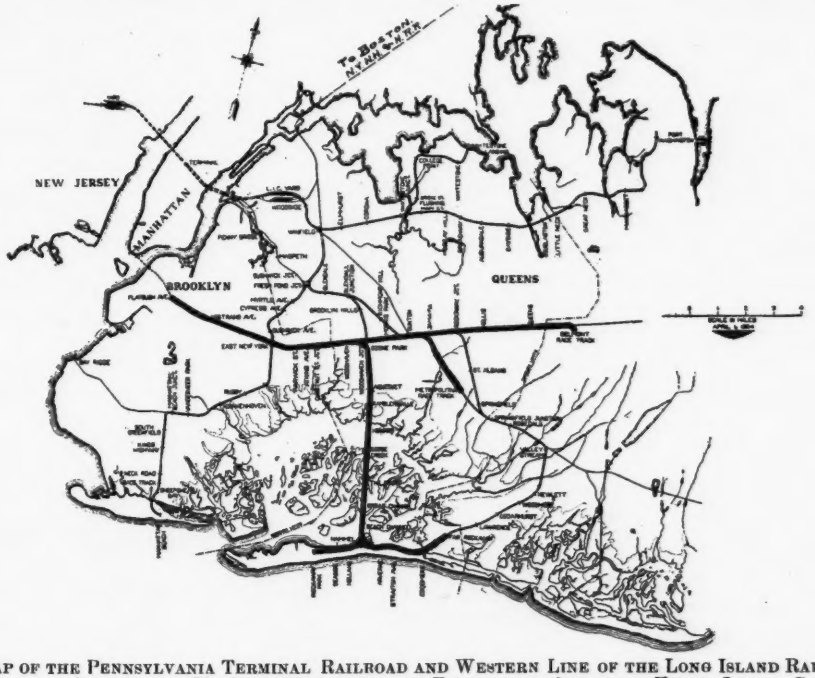
BY O. S. LYFORD, JR., AND W. N. SMITH.

A study of the general subject of electric traction for the suburban lines of present steam roads discloses some interesting features which do not necessarily arise as important factors in the selection of equipment for rapid transit lines in cities or the usual interurban lines. Furthermore, the many variables that enter into the problem lead to a serious question as to the necessity of the elaborate methods of determining train and motor characteristics which have been put forth in the recent literature on heavy electric traction. The advantage of simpler and shorter methods becomes very apparent.

Work now in progress for the Long Island Railroad Company may be taken as typical of projects of this character. It is the purpose of this paper to place before the Institute some of the questions brought out in the engineering of this work, and to describe more particularly some of the simple things that were done to facilitate decision regarding motor equipments for cars.

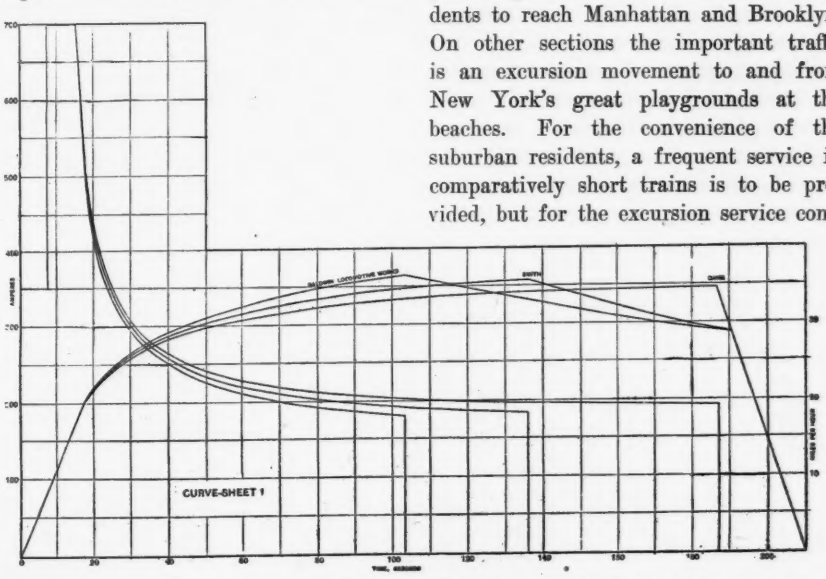
The Long Island Railroad system has at present two passenger terminals in the city of New York, one at Atlantic avenue and Flatbush avenue in the borough of Brooklyn and one at the Thirty-fourth street ferry in Long Island City, borough of Queens. When the great tunnels of the Pennsylvania, New York & Long Island Railroad Company are completed there will be a third terminal for the Long Island Railroad passenger traffic in the borough of Manhattan. From the present terminals there branches out an extensive system of through and suburban lines, over which is maintained a train service, both express and local, reaching all parts of the Island. In addition to the suburban service into these terminals there is an interchange of traffic with the Brooklyn Rapid Transit Company at two points, and a connection is to be established between the subway system of the Long Island Railroad and the extension of the Rapid Transit subway now being constructed between Brooklyn and the south end of Manhattan. The accompanying map shows the location of the western lines of the Long Island Railroad and the new connections which are to be made.

Extensive plans for the electrification of the suburban service of this road have been under consideration for some years.



MAP OF THE PENNSYLVANIA TERMINAL RAILROAD AND WESTERN LINE OF THE LONG ISLAND RAILROAD—PORTION TO BE FIRST CONVERTED TO ELECTRICITY SHOWN BY HEAVY LINES—CONNECTION OF ATLANTIC AVENUE LINE WITH INTERBOROUGH RAILWAY SYSTEM ALSO SHOWN.

These plans provide for the immediate adoption of electric traction on the lines emanating from Flatbush avenue and for a progressive extension of electric traction over all of the strictly suburban routes, as rapidly as the conditions shall justify. On some of these routes the traffic is of a purely suburban nature, providing facilities for out-of-town residents to reach Manhattan and Brooklyn. On other sections the important traffic is an excursion movement to and from New York's great playgrounds at the beaches. For the convenience of the suburban residents, a frequent service in comparatively short trains is to be provided, but for the excursion service comparatively long trains are necessary. As a result, the number of cars per train in this system will vary from one to eight



2-car train; weight 70.6 tons; 2 Westinghouse No. 86 motors; 19.63 gear; 36-inch wheel; run 1.67 miles, level; 540 volts.

Formula.	Time, Seconds.		Per Cent. Time Power on.	Speed, Miles per Hour.	Kilowatt-Hours.	Watt-Hours per Ton-Mile.
	Total	Power on				
Davis.....	210	187	89	28.6	7.51	63.6
Smith.....	210	136	65	28 6	5.76	48.8
Baldwin Locomotive Works.....	210	103	49	28.6	4.66	39.5

CURVE SHEET 1—COMPARATIVE TRAIN PERFORMANCES COMPUTED WITH DIFFERENT RESISTANCE FORMULAS.

[1] A paper presented at the 191st meeting of the American Institute of Electrical Engineers, New York, November 25, 1904.

or possibly ten. The initial service, limited to a maximum of six cars per train, results in fifty-two types of runs varying in number of cars per train and distance between stops. On some sections the lines are fairly free from grades and curves, but on others the grades and curves are heavier than would be supposed from a general knowledge of the contour of Long Island. These few statements will indicate, in a general way, the complex nature of the problem involved in the selection of a suitable electrical system for such a service and in the determination of types and sizes of apparatus to be used. In the working out of large enterprises, important details are frequently settled by quite simple processes of reasoning. Even in a complex problem like the one under consideration, some main points may be decided in this way.

TABLE I.

Average Speed and Watt-Hours Per Ton-Mile.—Comparison of Theoretical Results with Actual Tests.

G. R. G. H. & M. Ry. (Schedule speed the same.) Two No. 50-C Motors. Weight of Train, 29.5 Tons.

	Davis		Smith		Test	
Test No.	Miles per hour	Watt-hours per ton mile	Miles per hour	Watt-hours per ton mile	Miles per hour	Watt-hours per ton mile
1	27.9	98.	27.9	79.2	27.9	88.2
2	32.7	90.2	32.7	81.6	32.7	81.
3	30.4	85.7	30.4	75.0	30.4	98.2
4	30.6	115.1	30.6	111.5	30.6	110.

D. Y. A. A. & J. Ry. (Schedule speed the same.) Four No. 76 Motors. Weight of Train, 32 Tons.

	Davis		Smith		Test	
Test No.	Miles per hour	Watt-hours per ton mile	Miles per hour	Watt-hours per ton mile	Miles per hour	Watt-hours per ton mile
5	28.3	99	28.3	94.	28.3	99.
6	31.5	102.	31.5	96.	31.5	105.
7	33.4	95.	33.4	89.	33.4	97.

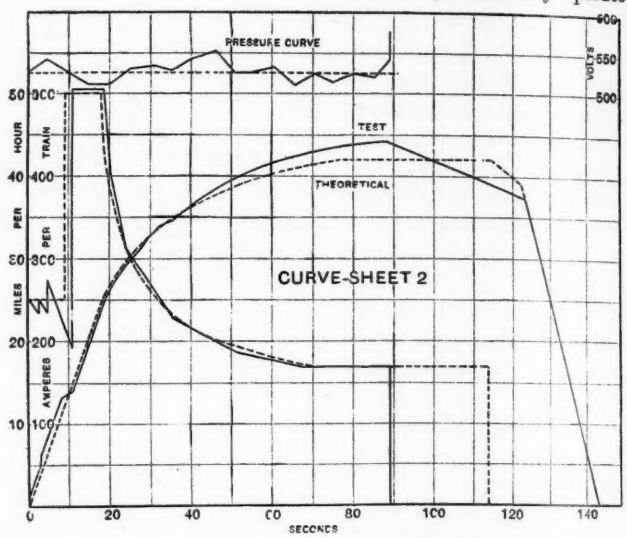
Arnold and Potter Tests.

Power cut off at same distance from start. (Schedule speed not the same.) Eight G. E. No. 75 Motors.

Test No.	Weight Train Tons	Davis		Smith		Test	
		Miles per hour	Watt-hours per ton mile	Miles per hour	Watt hours per ton mile	Miles per hour	Watt-hours per ton mile
8	228.5	28.6	87	27.6	72	27.1	79.4
9	201.5	27.7	98.5	28.4	84.5	28.4	92
10	175.5	29.2	102.	30.9	84.	29.9	96.3
11	148.5	29.6	111	30.6	89.5	30.6	93.4

(a) The number of cars per train varies from one to six, as stated. Eight or ten-car trains may be desirable at times. Such variations in train length can not be provided for economically with electrical locomotives. Motor cars must, therefore, be used, and for all except trains of one or two cars, more than one motor car per train is necessary. The multiple-unit system of motor-car operation is, therefore, best suited for this service.

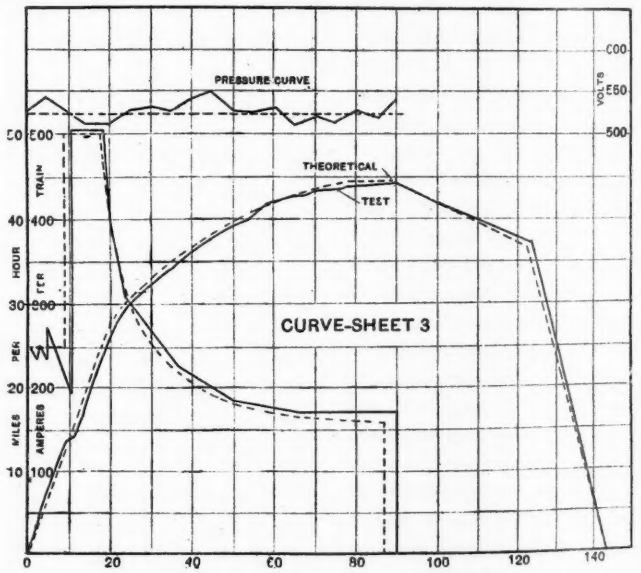
(b) The greatest flexibility for make-up of trains is obtained by making all cars motor cars.



CURVE SHEET 2—TEST NO. 2; G. R. G. H. & M. RY.

	Results. Plotted	Test.
Time, seconds	144	144
Distance, miles	1.31	1.31
Schedule speed miles per hour	32.7	32.7
Kilowatt-hours	3.83	3.13
Watt-hours per ton-mile	99.2	81

Single car; weight 29.5 tons; 2 Westinghouse No. 50 C. Motors.
Davis formula used in plotting run.
Note—Theoretical speed curves are corrected for variations in grade and pressure.



CURVE SHEET 3—TEST NO. 2; G. R. G. H. & M. RY.

	Results. Plotted.	Test.
Time, seconds	144	144
Distance, miles	1.31	1.31
Schedule speed miles per hour.	32.7	32.7
Kilowatt-hours	3.16	3.13
Watt-hours per ton-mile	81.6	81

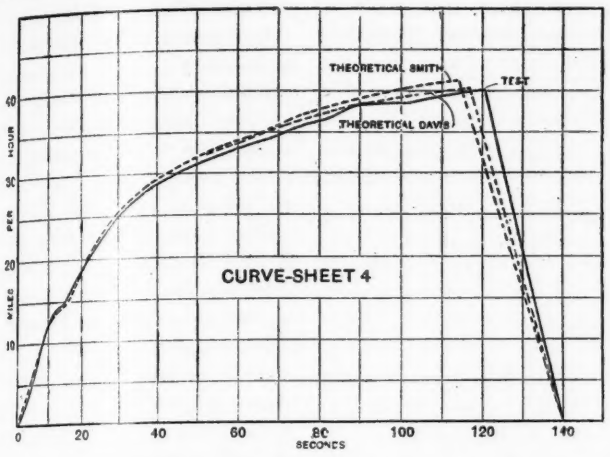
Single car; weight 29.5 tons; 2 Westinghouse No. 50 C. motors.
Smith formula used in plotting run.
Note—Theoretical speed curves are corrected for variations in grade and pressure.

(c) On the other hand the first cost of equipment and the cost of maintenance and inspection is least, if the motor selected is of the largest size practicable, and the number of equipments required is thus made a minimum.

(d) For a miscellaneous service of the character contemplated, all trains, both local and express, should preferably be provided with equipment having the same speed characteristics, so that all motor cars are available for all classes of service. (Trains may operate as express in one direction and as local in the other.)

(e) For express runs of this suburban service, averaging not over five miles between stops, a moderately high speed, say fifty to fifty-five miles per hour, is found by experience in steam practice to be most suitable. For these runs, therefore, it is essential that the electric trains shall be able to approximate these speeds.

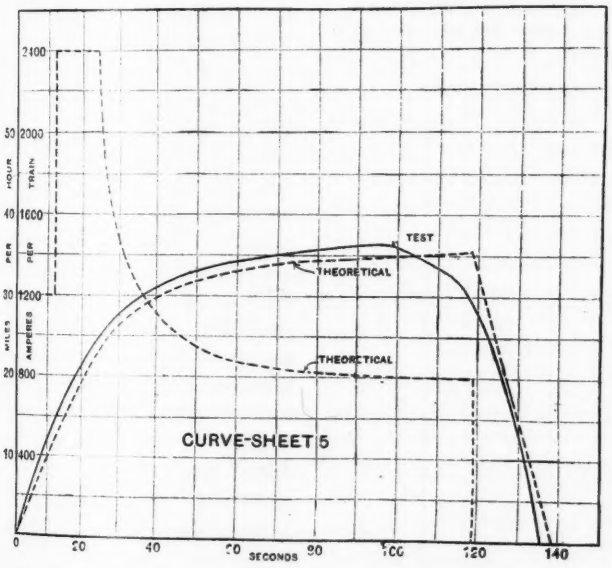
(f) Future development of the service, such as increase in number of stops and decrease in running time, will mean motor-car trains is of 200 horse-power nominal rating, two of these being about the limit of motor capacity that can be



CURVE SHEET 4—TEST NO. 5; D. Y. A. A. & J. RY.

	Results. Davis.	Test.	Smith.
e, seconds	140	140	140
ance, miles	1.1	1.1	1.1
edule speed, miles per hour	28.3	28.3	28.3
watt-hours	3 49	3.49	3.33
t-hours per ton-mile	99	99	94

Single car; weight 32 tons; 4 Westinghouse No. 76 motors.
Davis and Smith formulas used in plotting runs.
Note—Power cut off at same distance from start Average speed between stops maintained constant by varying braking rate.
Theoretical speed curves are corrected for variations in grade and pressure.



CURVE SHEET 5—TEST NO. 8; ARNOLD AND POTTER. RUN NO. 1.

	Results. Plotted.	Test.
e, seconds	138	135.5
ance, miles	1.02	1.02
edule speed, miles per hour	26.6	27.1
watt-hours	20 3	18.5
t-hours per ton-mile	87	79.4 by wattmeter

8 cars; weight 228.5 tons; 8 G. E. No. 55 Motors.
Davis formula used in plotting run.
Head wind, 15 miles per hour.
Average pressure, 570 volts.
Starting current, 300 amp. per motor.

arrier work for the motors. Therefore, asonable reserves must be provided in e equipment, and consideration must given to equipment which will make ssible a convenient increase in num- r of motors per train.

SIZE OF MOTORS.

The largest motor in general use for placed on a truck with thirty-three or thirty-six-inch wheels and a reasonably short wheel-base. On the basis of condition *(c)*, this should be the motor adopted, provided the train combinations can be effected satisfactorily with motors of this size. Condition *(f)* is also complied with by selecting the largest motor practicable, as the number of motors per train in the initial service will then be a minimum.

GEAR RATIO.

To meet condition *(e)*, a gear ratio must be selected which permits the operation of trains at high speed without damage to the equipment. On the other hand, the best starting conditions and least heating effect are obtained with high gear ratio. The gear ratio should, therefore, be as high as practicable and still permit of the maximum train speeds necessary for the express schedules. Provision must also be made for extra speeds which may occur on down grades. From observation of the existing service it was concluded that it is safe to assume sixty miles per hour as a maximum.

TRAIN WEIGHTS.

The motor cars of the service are to be new steel cars similar to those adopted for the Rapid Transit subway. For the determination of motor characteristics, trailer cars were assumed to have the same size and weight of bodies. The weights assumed were as follows:

	Motor Car.	Trailer.
Seated Load	81,000 lb.	60,400 lb.
Standing Load	88,000 lb.	66,000 lb.

These assumed weights are in practical agreement with the actual weights of the subway equipment.

The 200-horse-power motor was found to be the proper size for the service of the subway; but the schedule conditions are so different that this in itself does not signify that the same motors are suitable for the Long Island Railroad conditions where the distance between stops for the most of the local runs is greater than that of the express runs of the subway, and the express runs are longer in proportion. More or less of the usual calculating must, therefore, be done to reach a decision as to whether the characteristics of the standard motor of this size are suitable for this service, or whether a smaller size could be used to advantage.

In volume xix of the Transactions of the American Institute of Electrical Engineers and in the technical press of the last two or three years, there are a number of interesting papers giving theoretical and practical information regarding electric motors for railway service. Of these papers, that of Messrs. Arnold and Potter on "Acceleration Tests" gives some very interesting results of actual records of speed-time tests of steam and electric trains of different weights, illustrated by diagrams which admit of

close comparison between theoretical and practical results. The scholarly and somewhat bewildering papers by Mr. Mailloux and by Dr. Hutchinson are of interest as representing the academic side of some of the problems involved; and Mr. Gotshall contributes some very interesting illustrations of theoretical speed-time curves derived for a specific case.

The subjects of train resistance, acceleration rates, and rating of motors have been reported on at length and each investigator has viewed them from a different standpoint. The effect of the inertia of rotating parts of a train, previously neglected, has also been given its full share of importance. With all this information at hand, however, there are still some very pertinent questions which arise in the mind of an engineer approaching the solution of such a problem:

Which fellow is right?

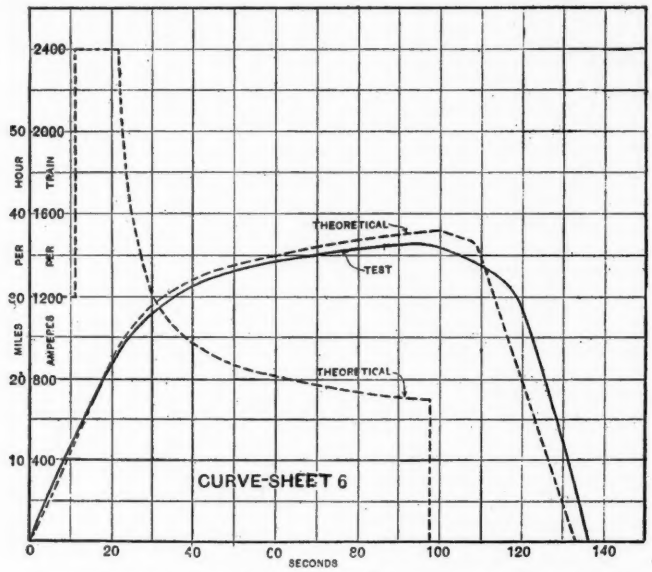
How much of this tedious calculating is necessary?

Whether used to overcome mechanical friction, head resistance, gravity, or inertia, how much power must be delivered to the motor cars to move a train from one terminus to the other?

How close will practice work out to theory?

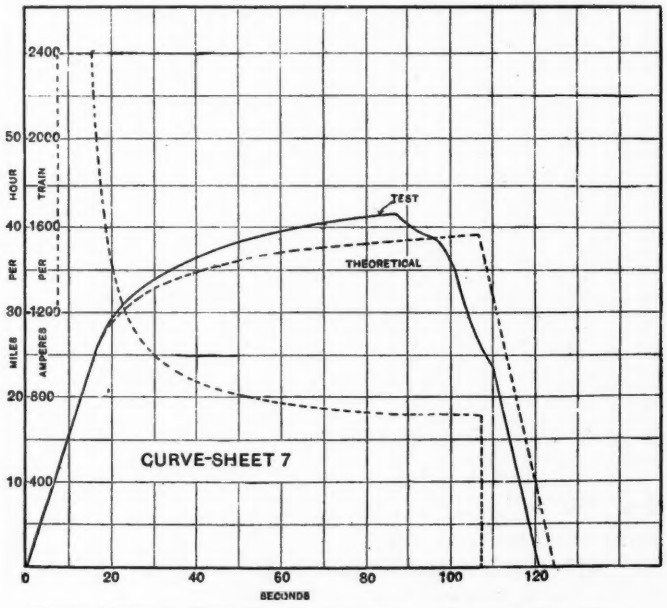
What allowance must be made for local limitations on the possible speed of train equipments?

Some of the things that were done to obtain satisfactory answers to these questions may be of interest to the members of the Institute.



CURVE SHEET 6—TEST NO. 8; ARNOLD AND POTTER. RUN NO. 1.

	Results. Plotted.	Test.	
Time, seconds	133	135.5	8 cars; weight 228.5 tons; 8 G. E. No. 55 motors.
Distance, miles	1.02	1.02	Smith formula used in plotting run.
Schedule speed, miles per hour	27.6	27.1	Head wind, 15 miles per hour.
Kilowatt-hours	16.7	18.5	Average pressure, 570 volts.
Watt-hours per ton-mile	72	79.4 by wattmeter.	Starting current, 300 amp. per motor.



CURVE SHEET 7—TEST NO. 11; ARNOLD AND POTTER. RUN NO. 7.

	Results. Plotted.	Test.	
Time, seconds	124	120	5 cars; weight 148.5 tons; 8 G. E. No. 55 motors.
Distance, miles	1.02	1.02	Davis formula used in plotting run.
Schedule speed, miles per hour	29.6	30.6	Head wind, 15 miles per hour.
Kilowatt-hours	16.7	14.3	Average pressure, 570 volts.
Watt-hours per ton-mile	111	93.4 by wattmeter.	Starting current, 300 amp per motor.

I—PLOTTED AND TEST RUNS COMPARED.

The power required to overcome inertia and gravity may be calculated with exactness. Train resistance, however, made up of head resistance, mechanical friction and skin friction, may be estimated only by empirical formulas, based on practice tests. Such formulas have been derived and published by various engineers. Owing to differences in character of equipment and roadbed, nature of the train service, design of car bodies and trucks, methods of test, etc., there are material differences in the conclusions reached. For ordinary electric-car service on urban and suburban lines, where the number of stops is frequent and the maximum speed is low, the train resistance is relatively unimportant as compared with the effect of inertia and grades, but as the speed increases the train resistance becomes a more important matter. The lack of agreement of these formulas when applied to the condition of the Long Island Railroad are illustrated in curve sheet 1 of the Davis and the Baldwin Locomotive Works formulas are extremes; they, therefore, afford a sufficient illustration of the divergence of authorities on this subject. These formulas are expressed as follows:

Baldwin Locomotive Works,

$$R = 3 + \frac{V}{6.}$$

W. J. Davis,

$$R = 4 + 0.13\,V + \frac{0.004\,AV^2}{T}\,[1 + 0.1\,(n-1)]$$

R = Train resistance in pounds per ton of 2,000 pounds.

V = Velocity in miles per hour.

A = Cross-sectional area of car in square feet.

T = Weight of train in tons of 2,000 pounds.

n = Number of cars per train.

The formula marked "Smith" is one suggested by one of the authors and has been found to give results close to actual practice as will be explained in the following paragraphs. This formula has the following expression :

$$R = 3 + 1.67\ V + 0.0025\ \frac{A}{T}\ V^2.$$

The speed-time curves on this sheet are derived for a two-car train with cars of weight and dimensions similar to those of the Rapid Transit Railway in Manhattan. The length of run is an average for the total Long Island suburban service. It will be noted that the power consumption (watt-hours per ton-mile) varies from 39.5 to 63.6, the figure according to Davis's formula being sixty-one per cent greater than the Baldwin figure. Moreover, if the conditions were such that the average speed of 28.6 miles an hour between stations had to be maintained, the speed-time curve of Davis would be impracticable because of no allowance in coasting to provide for possible delays, etc. Therefore, whereas the Baldwin formula indicates a satisfactory equipment working with very low power consumption, the Davis formula for the same equipment shows relatively a very high power consumption and an impracticable equipment. The necessity of careful investigation of this matter in connection with our problem is apparent.

APPLICATION OF FORMULAS.

The essential points which we wish to determine are the schedule speeds which can be obtained with given equipments, the power that will be required to obtain these speeds, and the heating effect on the motors. The value of train resistance is best determined at full speed, or while coasting; but except in the case of long runs most of the power is consumed in accelerating. By comparing actual test runs with plotted runs from start to stop, we get some check on the train resistance formulas, but, what is of more immediate importance, we get a verification of the accuracy of all the elements entering into our calculations.

To effect a comparison of theoretical results with actual tests, some special tests were made on the Grand Rapids, Grand Haven & Muskegon Railway, and on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway in Michigan. These tests were necessarily confined to trains of one car each. The tests reported by Messrs. Arnold and Potter, made at Schenectady, were on trains of greater lengths. To supplement the single-car data of trains of identical composition and equipment, theoretical runs were plotted for comparison with some of these Schenectady tests. The various comparisons made are summarized in table 1, which, therefore, shows the comparison of theoretical and actual results for trains of from one to eight cars per train.

On the G. R. G. H. & M. road the equipment consists of two 150-horse-power motors mounted on a heavy Baldwin truck with Gibbs suspension. The unequipped truck is also of the Baldwin make and the entire equipment is of the highest standard. On the D. Y. A. A. & J. road the equipment consists of four seventy-five-horse-power motors mounted on rather light trucks. Both roads have first-class roadbeds, well ballasted, and laid with seventy-pound rails of standard A. S. C. E. section. The tests were made on sections of track practically straight and level. A chronograph was used to determine the speed at every revolution of the wheels, and the current and pressure were read by observers simultaneously at five-second intervals. From these tests speed-time and current-time curves were plotted. In making these tests the instructions were to accelerate and brake at as high a rate as practicable, therefore the curves obtained may be considered as representing the best results obtainable in practice with the existing conditions.

For comparison with these actual tests, theoretical runs were plotted in which the length of run was made the same, the average speed was made the same where possible, and the average rate of braking was assumed to be the same as in the actual experiments. The curves were corrected for pressure and grade so as to conform as closely as possible to the condition prevailing during the test. The observed current readings were plotted and also the assumed theoretical values of the current corresponding to calculated speeds. The watt-hours per ton-mile were calculated from the observed tests either from wattmeter readings or by multiplying together the simultaneous voltmeter and ammeter readings. In the case of calculated runs, the value was obtained by integration, proper allowance being made for variation in pressure. The results of all the various tests are shown in table 1.

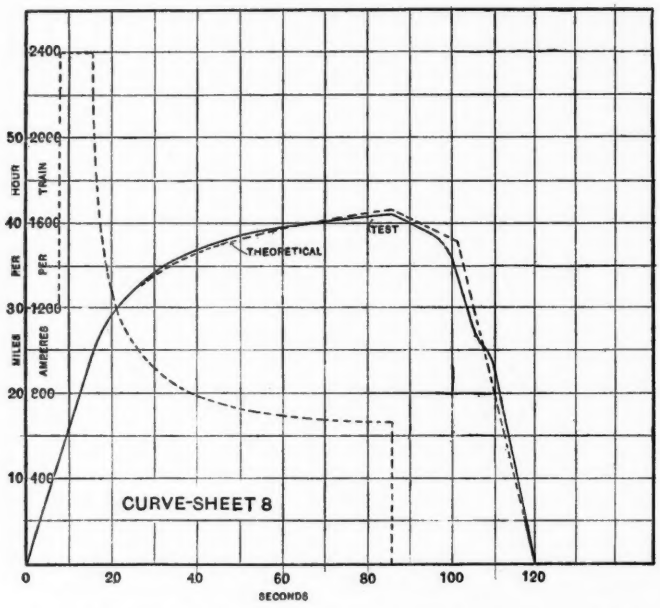
The characteristics of the test curves and the comparison with plotted runs on the G. R. G. H. & M. Ry. are illustrated by curve sheets 2 and 3. The differences resulting from the use of the Davis or the Smith formula are also indicated.

The D. Y. A. A. & J. Ry. tests are also summarized in table 1. The character of the results obtained is illustrated in curve sheets 4 and 5. In these tests there was no coasting, and the conditions were such as to cause a considerable drop in pressure during the first part of acceleration. This may have caused sufficient error in the readings to account for the lack of agreement between tests and the calculations based on the Smith formula. The power curves were plotted and the watt-hours per ton-mile were computed therefrom as in the other cases, but the current curves have not been reproduced on these sheets on account of the difficulty of plotting them all without confusion. The comparison between actual results and theoretical runs in the case of the Arnold and Potter tests was effected in the same manner as for the single car tests. See table 1 and curve sheets 5, 6, 7 and 8. It is at once evident from the comparative curves and the table of results that either of the two formulas for train resistance is reasonably close to the actual conditions. The exhibits when analyzed lead to the following conclusions as to the relative applicability of the two formulas.

The acceleration curve from the Davis formula conforms more closely to the tests for the D. Y. A. A. & J. car, but for the G. R. G. H. & M. car and for the Arnold and Potter trains it falls below the actual curve, in some cases to such an extent that the theoretical schedule speed is below the actual even with coasting eliminated. The Smith formula gives accelerations practically coincident with the G. R. G. H. & M. tests and somewhat higher than the actual for the other tests, the difference in any case not being sufficient to be misleading in the results as to schedule speed. This difference may easily be accounted for by difference in pressure or inaccuracies in observation of instruments. In the case of the D. Y. A. A. & J. car the type of trucks and the drops in pressure may either of them have caused the reduced acceleration. In the case of the Arnold and Potter tests, the most decisive point in the comparison is the fact that, under the prescribed condition of cutting off power at the same distance from the start and making the same length of runs in the

same time, to follow the Davis formula would not only necessitate the elimination of coasting, but would require braking at a practically impossible rate. In other words, if the Davis formula be correct the trains could not have made the runs in the time that they actually did make. The conclusion, therefore, is that the Smith formula most nearly represents the actual train resistance for all of these tests.

With reference to power required, the actual results appear to fall between the results obtained with either of the two formulas. The calculations based on the Smith formula are closer to the actual results in most cases. For the G. R. G. H. & M. car, where the acceleration curves agree, the watt-hours per ton-mile are also very close, and in the Arnold and Potter tests even with a reduced schedule speed the watt-hours per ton-mile are considerably greater for the Davis formula than for the observed tests. The conclusion reached is that the Smith formula affords a better basis for calculating the average speeds, and is sufficiently close for the determination of power required. Furthermore, the comparative results with these various train weights and types of motor, give us a confidence in all the assumptions made and in the customary use of the motor curves and other data furnished by the manufacturer.



Curve Sheet 8—Test No. 11; Arnold and Potter. Run No. 7.

	Results. Plotted.	Test.	5 cars; weight 148.5 tons; 8 G. E. No. 55 Motors.
Time, seconds	120	120	Smith formula used in plotting run.
Distance, miles	1.02	1.02	Head wind, 15 miles per hour.
Schedule speed, miles per hour	30.6	30.6	Average pressure, 570 volts.
Kilowatt-hours	13.5	14.3	Starting current, 300 amperes per motor.
Watt-hours per ton-mile	89.5	93.4	by wattmeter.

Test of Equipment Similar to That Proposed for the Long Island Railroad.

Through the courtesy of the Interborough Rapid Transit Company and the Westinghouse Electric and Manufacturing Company it is possible to present the record of a special test which has a direct bearing on this subject, because the type of motor equipment used in the test is the same electrically as that recommended for the Long Island Railroad project. On January 30, 1903, a test was made on the Ninth Avenue line of the Manhattan elevated railway, of the sample motors submitted by the Westinghouse Electric and Manufacturing Company as representing the motors which that company was to furnish to the Interborough Rapid Transit Company. In these tests the train weight corresponded closely with the weight per motor of the equipment proposed for the Long Island Railroad and the motors were of the same size and general characteristics. The length of the test run was too short to permit the cars to reach maximum speed; as the value of train resistance is best determined at maximum speed, this test can not by itself be considered an absolute check on calculated curves.

When viewed in the light of tests of other equipment on longer runs, however, it affords a good indication as to how close this specific equipment will conf to the theoretical basis of our determi tions. The results of this test are gi in curve sheets 9 and 10. Curve sh 9 gives the results of a north-bound between Ninety-third street and Hundred and Fourth street, and cu sheet 10 gives results for a south-bo run on the same section of road. Ac results are indicated by the solid li and for comparison there are given on same curve sheets curves calculated the corresponding conditions according the train resistance formula and theoretical methods used in the calcu tions for the other exhibits hereof for all Long Island Railroad determi tions. In these tests the braking rate not constant but increased as the sp decreased, and for comparison the s braking curve was assumed for the t retical as for the test run.

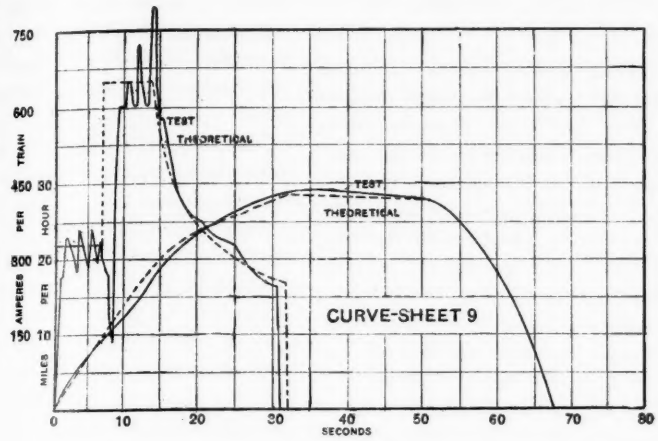
The results in these comparative cur are tabulated on the respective sh The theoretical run was plotted to ob the same average speed as the test. T involved assuming the power applied a longer period than the test in one c and a shorter period in the other. In b cases, however, it will be noted that power requirements (watt-hours per mile) and the square root of mean sq current are greater for the theoretical than for the test. Furthermore, it be noted that the average starting c rent per motor was less in the test t in the theoretical run. The conclusi derived from this exhibit are as follow

(*a*) The motor control did not per of the rapid application of power assu in the calculations, time being lost going from series to parallel. This, h ever, did not affect the results adverse

(*b*) At the maximum speed when rent was on, namely, twenty-six to twe eight miles per hour, the theoretical cu shows practically the same energy c sumption as the test. This indicates t the train resistance was practically calculated. For corresponding speed the motor curve, the power required cording to theory is in both cases slig higher than the power required accord to test; this indicates that the Smith mula gives a train resistance which slightly higher than the actual resista for this equipment. The Davis formu giving higher values than Smith wo give results still further from the act conditions.

(*c*) The calculations for energy c sumption and square root of mean sq current give results slightly higher t the test.

(*d*) The theoretical methods, therefore, give values which are slightly on the safe side for short runs.

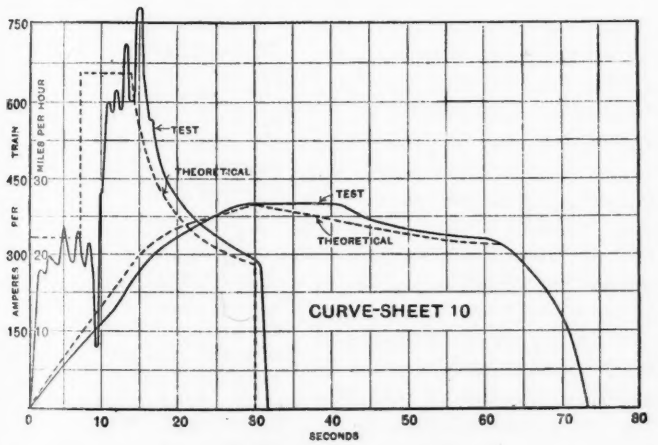


CURVE SHEET 9—COMPARISON OF TEST AND THEORETICAL TRAIN CURVE USING ACTUAL BRAKING CURVE.

Test made on Ninth Avenue line of Manhattan Ry. Co., Jan. 30, 1903.
Pressure 580 volts; 1 motor car; 1 trailer; weight 62.5 tons; distance 2,065 ft., 93d street to 104th street; 2 Westinghouse No 86 motors; gear 19:63; 33-inch wheels.

	Results. Test.	Theoretical
Average speed without stop	20.9	20.9
Schedule speed with 15-second stop	17.05	17.05
Kilowatt-hours per run	1.93	2.13
Kilowatt-hours per car-mile	2.475	2.72
Watt-hours per ton-mile	79.3	87.2
Average kilowatts per train	84.3	92.9
Square root mean square current per motor for 85 seconds	149.0	157.5
Starting current per motor	294.0	325.0

Smith formula used in plotting run.



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Test made on Ninth Avenue line of Manhattan Ry. Co., Jan. 30, 1903.
Pressure 580 volts; 1 motor car; 1 trailer; weight 62.5 tons; distance 2,090 feet, 104th street to 93d street; 2 Westinghouse No. 86 motors; gear 19:63; 33-inch wheel.

	Results. Test.	Theoretical.
Average speed without stop	19.32	19.32
Schedule speed with 15-second stop	16.10	16.10
Kilowatt-hours per run	1.91	2.06
Kilowatt-hours per car-mile	2.415	2.65
Watt-hours per ton-mile	77.0	83.0
Average kilowatts per train	77.3	82.5
Square root mean square current per motor for 85 seconds	145.2	157.0
Starting current per motor	300.0	325.0

Smith formula used in plotting run.

(*e*) The tests do not afford direct evidence of the accuracy of the theoretical methods when applied to longer runs with higher speeds, but the indications are that for such runs the theoretical values will also be on the safe side and close enough for all practical purposes.

(To be concluded.)

An Interesting Meeting of the Washington Branch of American Institute of Electrical Engineers.

The first fall meeting of the Washington branch of the American Institute of Electrical Engineers was held in the lecture hall of the George Washington University on November 16. Colonel Samuel Reber, president of the society, in opening the meeting, delivered a brief and forcible address, welcoming the members and visitors and expressing the hope "that the work of the coming season will broaden the scope of our local activities, better our acquaintances with each other, bring together all electrical engineers and those who are interested in electricity, extend the membership and increase the influence of our Institute."

The topic for the evening was "The Transmission of Intelligence," but the time was not devoted entirely to the discussion of the papers presented to the Institute in New York at its October meeting. Colonel Reber presented the subject and stated that "in the entire field of human activity there has been no greater agent in advancing both the intellectual and material progress of mankind and in broadening civilization than the part played by rapid dissemination of information by mail, telegraph, telephone, submarine cables and by wireless communication." He gave a clear and concise account of the earliest mail service commenced in 1544; of the signal fires of the American Indians; the French semaphore systems; the invention of the Morse telegraph and the Bell telephone. Reference to the wireless telegraph system was deferred until a later time, when an evening will be given to the subject.

"The Transmission of Intelligence by the Mails" was the title of a valuable paper prepared under the direction of Postmaster-General Wynne by one of his assistants in which the growth of the United States postal service, from its origin in Boston in 1677 to its great magnitude in 1903, when more than seventeen billion pieces of first-class mail and thirty million pieces of registered mail were transported, was outlined.

"The Early History and Development of Telegraphy" was the subject assigned to Mr. George C. Maynard, of the Smithsonian Institution, who brought out some interesting facts in a ten-minute talk and was followed by Mr. J. W. Collins, chief operator of the Western Union telegraph office, who gave a most interesting account of the present methods of operating a great telegraphic system and, at

the request of President Reber, closing with a statement of the effects of the heavy snow-storm on November 13, which broke down every wire leading out of Washington, except one connecting that city with Cincinnati. On that day a heavy fall of wet snow lasting about six hours formed such an accumulation on the wires that many miles of the stoutest poles were broken down. Along the B. & O. railroad between Washington and Baltimore many poles fell on the tracks. After these were removed the locomotives caught the mass of tangled wires and dragged them away. It became necessary to practically rebuild considerable stretches of this line, a task to which the company set itself so vigorously that, at the end of the third day after the storm, fifty out of the ninety Baltimore wires were in working order.

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Mr. C. O. Mailloux, replying to allusions to an earlier paper of his own on predetermination of speed-time characteristics, said he was pleased to find that his entirely theoretical considerations had given results so near to those obtained from actual tests, that he had applied the formulæ composed by himself to the conditions considered in the paper, and had found that the curves plotted in this way were surprisingly close to those obtained in the tests. He pointed out the necessary limitations within which empirical formulæ of this kind can be applied. They are only suitable for runs on straight tracks, and can not be used where there is a considerable change in grade or many curves. Mr. Mailloux held that all the formulæ put forward would necessarily be modified as more light is obtained and more data compiled, that as there are so many variables, no final solution can be made. One effect which has been ignored is the starting resistance. This is undoubtedly responsible for the discrepancies given in the different formulæ at low speeds. Reference was made to the work which is being conducted by the railway testing committee at St. Louis, and the hope expressed that this would do much toward throwing out unreliable equations and possibly improving the more satisfactory ones.

Mr. H. Ward Leonard discussed, at some length, the possibilities of what he called "heaviest electric traction." He said that an approximate figure for the locomotive equipment of the trunk lines of this country is 120 horse-power per mile of track. This is based upon the maximum output of the steam locomotive. On the Pennsylvania Railroad it is figured as 555 horse-power per mile of track; while on roads where the heaviest freight trains are operated, it amounts to about 1,000 horse-power per mile of track. The steam locomotive costs about five cents per pound, including the tender. This, however, amounts to nine cents per pound of weight on the drivers. He believes that electric locomotives for heavy freight service can be built for less than that figure when the construction has been standardized. He also believes that when the equipment of a road amounts to 250 horse-power per mile, electric traction can replace steam with decided economy. The cost of the electrical equipment will not be more than fifteen per cent of the existing capital of the road, while electrical operation will bring many advantages, such as increase in acceleration, decrease in maintenance, etc. Comparing the heaviest steam locomotives now constructed with the Oerlikon locomotive equipped with the Ward Leonard system, he found that the former gave 117 pounds per horse-power on the drivers, while the electric locomotive gave 120 pounds.

Mr. A. H. Armstrong criticised the paper somewhat in detail, pointing out what seemed to him to be discrepancies. It was said that the curves, as plotted, did not agree with the motor characteristics as assumed. He held that the method of computing the temperature of the motor, based on the square root of the mean square of the current, was not reliable. Other losses are ignored, such as core losses and brush friction losses, and these are very important.

Dr. Cary T. Hutchinson, referring to certain allusions made to his own work in this field, said that his method was essentially a shorthand, approximate way of getting results, which, if correct within ten per cent, were entirely satisfactory as a first estimate. He had applied his method to the conditions assumed in the paper, and was pleased to find very good agreement. The temperature of the motor was a most important factor in selecting equipment. This can only be computed

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THE one hundred and ninety-first meeting of the American Institute of Electrical Engineers was held at Carnegie Hall, New York city, November 25. The meeting was called to order by President J. W. Lieb, Jr., who after a few remarks on the great development in electric traction work which had taken place, and the probability that the work to be done in the near future would be even greater, introduced Mr. O. S. Lyford, Jr., who read an abstract of a paper presented by himself and Mr. W. N. Smith, entitled "Problems of Heavy Electric Traction." This paper will be found on another page of this issue. In it the authors describe the methods adopted for selecting the electrical equipment for that section of the Long Island Railroad which is to be operated electrically.

In opening the discussion, Mr. L. B. Stillwell referred to the typical run of a subway train, which was used by the authors in their paper, which, he said, did not show the performance of the final subway equipment. In the former the method of cutting out the rheostat was somewhat irregular, while the ideal method called for a regular increase in acceleration. The new controllers more nearly met these requirements. Another point to be borne in mind in using these results as a basis of calculation was the method by which they had been obtained. The data had been taken down by observers, one reading each instrument at short intervals, while other observers made note of the maximum and minimum indications. Where violent changes take place this method is not accurate. In fact, it had been found that the actual acceleration was less than that given by the theory. The various formulæ of train resistance give values too low. It is probable that the error in the Baldwin formula was due to the type of train used in the experiments in which it was deduced. This train consisted of trail cars only, which had been run long enough to have their bearings worn smooth. Mr. Stillwell did not think that an accurate determination of the train friction was very important for short runs, since, under these conditions, the loss in braking amounts to about two-thirds of the total power absorbed by the train. He exhibited a diagram showing a typical express run made during April of the present year on the Manhattan elevated system. In this the predetermined values are in good agreement with those actually obtained. It was pointed out also that the brake line, which is usually assumed to be straight, is in general curved, since with a given pressure on the brake shoes the braking effect varies with the speed of the car. Mr. Stillwell also called attention to the difference in pressure on the wheels of the trucks which had been observed during certain experiments, when it was found that one pair of wheels would slip before the other. The effect is due to the moments of forces acting on the truck. He thought it was advisable to reduce, as far as possible, the number of motors in the equipment, as this simplified control of the system and decreased the expense. It also allowed further increases to be provided for without adding additional motors to the cars. He thought that the acceleration to be obtained on the Long Island Railroad might be increased, and this would probably be done as a means of increasing the earning power of the property.

Mr. C. O. Mailloux, replying to allusions to an earlier paper of his own on predetermination of speed-time characteristics, said he was pleased to find that his entirely theoretical considerations had given results so near to those obtained from actual tests, that he had applied the formulæ composed by himself to the conditions considered in the paper, and had found that the curves plotted in this way were surprisingly close to those obtained in the tests. He pointed out the necessary limitations within which empirical formulæ of this kind can be applied. They are only suitable for runs on straight tracks, and can not be used where there is a considerable change in grade or many curves. Mr. Mailloux held that all the formulæ put forward would necessarily be modified as more light is obtained and more data compiled, that as there are so many variables, no final solution can be made. One effect which has been ignored is the starting resistance. This is undoubtedly responsible for the discrepancies given in the different formulæ at low speeds. Reference was made to the work which is being conducted by the railway testing committee at St. Louis, and the hope expressed that this would do much toward throwing out unreliable equations and possibly improving the more satisfactory ones.

Mr. H. Ward Leonard discussed, at some length, the possibilities of what he called "heaviest electric traction." He said that an approximate figure for the locomotive equipment of the trunk lines of this country is 120 horse-power per mile of track. This is based upon the maximum output of the steam locomotive. On the Pennsylvania Railroad it is figured as 555 horse-power per mile of track; while on roads where the heaviest freight trains are operated, it amounts to about 1,000 horse-power per mile of track. The steam locomotive costs about five cents per pound, including the tender. This, however, amounts to nine cents per pound of weight on the drivers. He believes that electric locomotives for heavy freight service can be built for less than that figure when the construction has been standardized. He also believes that when the equipment of a road amounts to 250 horse-power per mile, electric traction can replace steam with decided economy. The cost of the electrical equipment will not be more than fifteen per cent of the existing capital of the road, while electrical operation will bring many advantages, such as increase in acceleration, decrease in maintenance, etc. Comparing the heaviest steam locomotives now constructed with the Oerlikon locomotive equipped with the Ward Leonard system, he found that the former gave 117 pounds per horse-power on the drivers, while the electric locomotive gave 120 pounds.

Mr. A. H. Armstrong criticised the paper somewhat in detail, pointing out what seemed to him to be discrepancies. It was said that the curves, as plotted, did not agree with the motor characteristics as assumed. He held that the method of computing the temperature of the motor, based on the square root of the mean square of the current, was not reliable. Other losses are ignored, such as core losses and brush friction losses, and these are very important.

Dr. Cary T. Hutchinson, referring to certain allusions made to his own work in this field, said that his method was essentially a shorthand, approximate way of getting results, which, if correct within ten per cent, were entirely satisfactory as a first estimate. He had applied his method to the conditions assumed in the paper, and was pleased to find very good agreement. The temperature of the motor was a most important factor in selecting equipment. This can only be computed

when all the factors entering into the heating are taken into consideration. Applying his own method to this determination, he had found that the heating of the motors in the various cases presented in the paper would, in most cases, be excessive and not permissible.

Professor W. S. Franklin, referring to the discrepancy of the various train resistance formulæ, said that those who had put forward these were striving to obtain something that did not exist. There are too many variables, and the element of chance enters into this question so largely that there can be no equation which will fit all the conditions. He thought that, rather than searching for a formula applicable to all conditions, engineers should turn their attention toward finding out what are the ranges of variation which must be expected in practice, and what factor of safety should be assumed in order that the service may be maintained.

Mr. Elias E. Ries said that a large percentage of the total load was composed of dead load. He thought that railway men should turn their attention toward this, with a view of diminishing the dead load.

In reply to these remarks, Mr. W. N. Smith presented the formula which he had put forward as simply tentative, and which was justified by the good results which it gave. He did not think the starting resistance of the train entered much into the problem where the runs are fairly long. In regard to predetermining the temperature of the motors, this could only be done in the way suggested when the consulting engineer had at his fingers' ends a large amount of data on motor operation. This is purely a problem for the designer, whose duty it is to meet the conditions prescribed by the consulting engineer. Another factor entering into this question is that of the relative positions of the motors. A slight change here may cause a considerable difference in temperature, due to better ventilation or other cause. It is impossible to allow for all these factors. He laid stress upon the value of the graphical methods of solving such problems since they are quick, easy and check themselves at all points.

Mr. O. S. Lyford said that the discrepancies pointed out by Mr. Armstrong were due partly to the source from which their information had been obtained. They had made use of the Institute Transactions and there was, no doubt, some error in the reproduction of the curves. Some of the apparent inconsistencies were due to the conditions assumed.

Report of the Canadian Commission on Electrothermic Processes for the Production of Iron.

Last December the minister of the interior of the Dominion of Canada appointed a commission to investigate and report upon the different electrothermic processes employed in the smelting of iron ores and the making of different classes of steel. This commission was to proceed to Europe, visiting different plants in operation, and obtain such data as could be had. It consisted of Dr. Eugene Haanel, superintendent of mines, chairman, and Mr. C. E. Brown, electrical engineer. After reaching England, Mr. W. W. Harbord was retained as metallurgist of the commission. The report of this commission has been issued. It contains the reports of the chairman and of the electrical engineer and the metallurgist. There have also been appended descriptions of other processes which have not yet been put in application. The whole report is the most complete review of the electrical production of iron which has yet been published.

The first point to be visited was that using the Kjellin process, at Gysinge, Sweden. At these works steel of superior quality is made by melting together charcoal, pig and scrap in electric furnaces of the induction type. This furnace was described in the ELECTRICAL REVIEW, volume xliv, page 503. The process does not admit of purification of materials, and the quality of steel depends upon the purity of the component materials employed. A furnace of this type, using 600 horse-power, costs, according to Mr. Kjellin, about $4,000. Mr. Brown reports that the absorption of electrical energy per ton of product was, in one case, 0.16, and in another, 0.145 electrical horse-power-year. Mr. Harbord reports that the estimated cost of steel in this process is $34 per ton of 2,000 tons. The cost per electrical horse-power per year at this establishment is $11.50.

The next establishment visited by the commission was at Kortfors, Sweden, where the Héroult process of making steel has been in operation. The furnace, when visited by the commission, was used for making ferrosilicon. Its operation was shown, but no measurements were made, and the same furnace was to be tested later at La Praz, the establishment next visited.

The Héroult furnace used at La Praz is of the tiling pattern. It consists of a cast-iron casing lined with dolomite brick, with magnesite brick around the openings. Electrical energy is passed into the furnace by means of two large electrodes inserted through the roof of the furnace. At the Kortfors furnace these electrodes were water-jacketed for a short distance above and below their passage through the iron casing of the roof. An alternating current of 4,000 amperes, 110 volts, was employed. Regulation is secured by adjusting the width of the air-gap between the electrodes and the slag line. The electrodes are thirty-six centimetres on the side, 107 centimetres long, made from retort carbon. M. Héroult states that a furnace which holds a charge of 2,500 kilogrammes costs, with the necessary equipment complete, about $10,000. This does not include the generating machinery. Measurements made on this furnace showed an absorption of electrical energy per ton of steel amounting to 0.153 electrical horse-power-year (English unit). If tapped before the contents are completely purified, the product may be employed for structural steel. The energy consumed then is only one-tenth of a horse-power per year per ton. Various grades of steel are made at the La Praz works, among these being steel of exceptional hardness, medium hard steel, tough steel, and tough mild steel. Some experiments were made at this furnace in the production of pig, which showed the simplicity of the process for producing iron ores electrically. These experiments were not intended to give a figure indicating the cost of production of pig iron by this process.

The Stassano process, which is employed at Turin, Italy, was investigated. This furnace is of the arc type, and makes use of three-phase, alternating currents at ninety volts and 400 amperes per phase. Three electrodes nearly meet in the centre of the furnace. The distance apart is regulated hydraulically. The furnace is rotated during operation so as to produce a proper intermixture of the melting mass. A furnace of this type, having a capacity of 1,000 horse-power, would cost about $5,000 and have an output per day of four or five tons, depending upon the quality of the ore used. Twenty such furnaces would be required to give an output of 100 tons per day. A current of 4,900 amperes at 150 volts would be used. The electrodes are cylindrical, fifteen centimetres in diameter, and about one and one-half metres long. One man is required at each furnace to regulate the arc, and one for charging two furnaces, if provided with proper machinery. Five men are required for tapping six furnaces.

At Livet, Isere, France, the Keller

process was investigated. Here the most important experiments were conducted. This furnace was described in the ELECTRICAL REVIEW, volume xlii, page 794. It is of the resistance type, and is continuous in its operation. In shape the furnace resembles the ordinary blast furnace, the charge being fed in at the top and gradually sinking to the bottom as the finished product is drawn off. When material is to be purified a further treatment takes place before the charge is drawn. The electrodes are eighty-five centimetres on the side, each being made up of four smaller electrodes about one and one-half metres in length. It is said that the waste of the electrodes is very small. After thirteen days of continuous operation they had decreased in length only one-third. These electrodes were employed for a furnace having an output of ten tons per day of twenty-four hours. With this furnace three sets of experiments were made: first, the electrical reduction of iron ore, in order to obtain different classes of pig; second, the electrical reduction of iron ore containing a definite amount of carbon in the charge, with a view of ascertaining the amount of electrical energy absorbed in the production of one ton of pig iron; third, the manufacture of ordinary steel of good quality from the pig manufactured in the preceding experiments. The different classes of pig iron were obtained without difficulty, the men employed being ordinary Italian laborers without any special training.

The data obtained from the electrical experiments are given in Mr. Brown's report. The cost per ton of pig with Keller's process is $10.71. The energy consumed was 0.226 electrical horse-power-year, and this is charged for at the rate of $10 per horse-power-year. The experiments performed at Livet have shown that to produce 100 tons per day will require 9,750 electrical horse-power at the electrodes of the furnace. To provide for this and other necessary work, the generating plant should be rated at not less than 11,000 horse-power, or 12,000 hydraulic horse-power. For a plant having such an output, Mr. Keller would advise the installation of five active furnaces, each furnace having four hearths, and each furnace capable of absorbing 2,000 horse-power. The pressure would be seventy volts per group of two hearths. The current intensity corresponding to this power, and assuming a power-factor of seventy-five, would be 28,000 amperes, or 14,000 amperes per hearth. During the commission's visit the Livet furnaces were working with an intensity of 12,000 amperes.

In the section of the report covering the work of the electrical engineer, the arrangements adopted for determining the energy consumption are described, and the results are given. Some of these have already been quoted. It was found that the cost of electrical energy per ton of ingot by the Kjellin process was $1.60, this being charged for at the rate of $10 per horse-power-year. In the hearth furnace the cost of energy per ton of ingot at the same rate is $1.70 in one experiment, and $1.11 in another, the first being for soft steel, and the other for tool steel. With the Keller process the cost of electrical energy per ton is $1.25.

Probably the most interesting part of this report is that contributed by the metallurgist. Mr. Harbord describes the various experiments conducted, giving, in each case, the raw material used and the product. The latter was tested mechanically and analyzed. Very few difficulties were encountered in the work. The following is his summary:

The three processes of electric steel manufacture which the commission has had an opportunity to investigate are all capable of producing equally good steel, and the selection of one or the other will depend upon local conditions.

The Kjellin process is undoubtedly the nearest approach to the crucible process, but, given a high-class pig iron and scrap, has much to commend it. A special point being that the operation is conducted in a closed crucible or hearth, and there is no possibility of impurity being introduced by contact with electrodes. Its application, however, is limited, and although some purification can be effected during melting, the quality of the steel will largely depend upon the raw material being very pure, in the same way, although to a somewhat smaller extent, than in the crucible process. To what extent phosphorus, etc., can be removed, the experiments did not determine.

On the other hand, furnaces of the resistance type, with electrodes, can treat phosphoric scrap and pig iron in the same way as the gas-fired Siemens furnace. The neutral atmosphere and the intense heat which it is possible to obtain enable very basic slags to be used, and the mechanical arrangements allow the ready removal of the slag, so that a pure, non-oxidizing slag, to remove the last traces of phosphorus, can be ensured at the end of the operation. This undoubtedly opens a larger field for the resistance furnace, as in the many districts common scrap can be obtained at a moderate price, where materials suitable for the induction furnace could only be obtained at a prohibitive price. They are, as regards quality, both able to make highest class carbon steels, but, from a practical point of view, the resistance furnace is more adaptable as regards its raw material, and has the advantage of being very similar in general design to the ordinary Siemens furnace, so that, so far as metallurgical operations are concerned, repairs, etc., an ordinary steel smelter could, in a very short time, manage the furnace as easily as the gas-fired Siemens furnace.

In the present stage of development neither type of furnace can be regarded as a competitor of either the Siemens or the Bessemer processes for the production of rail and structural rail. It can only compete successfully in the production of high-class crucible steel or steels for ordnance and other special purposes, made in the Siemens furnace. In such cases, where very large steel castings are required, of crucible steel quality, several electric furnaces, working so that they could be tapped into a common receptacle before pouring the steel into the mould, should give excellent results and be much more economical than the crucible process. Under favorable conditions, electric energy might compete with gas as regards cost, but until it is possible to use furnaces of from thirty to forty tons capacity, the extra labor charges inseparable from small furnaces will prevent them from holding their own against the Siemens and Bessemer processes.

The following are the conclusions given by Mr. Harbord as the result of his investigations into the metallurgical production of steel and the electric smelting of pig iron. Steel equal in all respects to the best Sheffield crucible steel can be produced either by the Kjellin, Héroult or Keller processes, at a cost considerably less than the cost producing high-class crucible steel.

At present, structural steel, to compete with Siemens or Bessemer steel, can not be economically produced in electric furnaces, and such furnaces can be used commercially for the production of only very high-class steel for special purposes.

Speaking generally, the reactions in the electric smelting furnace, as regards the reduction and combination of iron, silicon, phosphorus and manganese, are similar to those taking place in the blast furnace. By altering the burden and regulating the temperature by varying the electric current, any grade of iron—gray or white—can be obtained. The change from one

grade to another is effected more rapidly than in the blast furnace.

Gray pig iron, suitable in all respects for acid steel manufacture, either by the Bessemer or Siemens process, can be produced in the electric furnace.

Gray pig iron, suitable for foundry purposes, can be readily produced.

Pig iron, low in silicon and sulphur, suitable either for the basic Bessemer or the basic Siemens process, can be produced, provided that the ore mixture contains oxide of manganese, and that a basic slag is maintained by suitable additions of lime.

It has not been experimentally demonstrated, but from general considerations there is every reason to believe that pig iron, low in silicon and sulphur, can be produced, even in the absence of manganese oxide in the iron mixture, provided a fluid and basic slag be maintained.

Pig iron can be produced on a commercial scale at a price to compete with blast-furnace iron only when electric energy is very cheap and fuel very dear. On the basis taken in the report, with electric energy at $10 per electrical horsepower-year and coke at $7 per ton, the cost of production is approximately the same as the cost of producing pig iron in the modern blast furnace.

Under ordinary conditions, where blast furnaces are an established industry, electric smelting can not compete, but in special cases, where ample water power is available and blast-furnace coke is not readily obtainable, electric smelting may be commercially successful.

It is impossible to define the exact conditions under which electric smelting can be successfully carried on. Each case must be considered independently after a most careful investigation into local conditions, and it is only when these are fully known that a definite opinion as to the possibilities of any project can be given.

To the report is added a description of the Ruthenburg process of electric smelting of magnetite; two papers by M. Henri Harmet, on the electrometallurgy of iron; a paper by Gustave Gin, describing the Gin process; a full description by Captain Ernesto Stassano of his methods of producing iron ore in the electric furnace, and a paper by M. Ch. Vattier, describing the Keller process.

The report also contains numerous illustrations of the furnaces described, and a large number of descriptive drawings.

DEPRECIATION ON THE BOSTON ELEVATED RAILWAY.

BY HOWARD S. KNOWLTON.

The elevated division of the Boston Elevated Railway Company's system has now been in operation about three and one-half years. The problems in construction and operation, which the management has faced from the earliest days of the road, are in a general way familiar to the readers of the engineering press and those who have availed themselves of the privilege of inspecting the overhead structure and subway in person under the guidance of one of the company's officials. Perhaps the special problem of track depreciation was never so well brought out, however, as in the recent meeting of the New England Street Railway Club in Boston, when Mr. H. W. Steward, roadmaster of the elevated division, presented a paper on "Track Construction and Maintenance."

The transportation problem in Boston is greatly complicated by the contortions of the streets, and the influence of the city's bewildering geography is felt even upon tracks which run above and below the regular thoroughfares. The elevated lines constitute a double-tracked trunk route between the business centre and the outlying districts of Charlestown and Roxbury. As all the high-speed through traffic of the city in a north and south direction passes over the elevated division, it is evident that continuity, reliability and safety of train movement are of prodigious importance.

At the present time the total elevated trackage is slightly over sixteen miles. The distance between the Sullivan square terminal at Charlestown and the Dudley street terminal in Roxbury is approximately five and one-quarter miles. The trains make a schedule speed of fourteen miles and a maximum of forty miles per hour. During rush hours thirty four-car trains are in service at a time without causing delays at terminals or junctions. The average daily car mileage is 20,000, and an average of over 100,000 passengers are handled at each terminal every day, about 60,000 being also handled at the Park street subway station. About 550 men are required to operate the trains, man the stations, towers, yards, etc.; the road department uses 130, and the repair shops 150 more. In a single day 26,000 passengers have been admitted at an island station attended by two ticket sellers and two ticket choppers.

Aside from the heavy traffic, the physical characteristics and layout of the road and equipment make for extraordinary wear and tear. There are eighteen curves of less than 100 feet radius and sixteen others with less than 150 feet radius—in fact, over forty per cent of the line is curved. Two up and two down grades of five per cent connect the elevated structure with the subway, and there is in one place a down grade of eight per cent with a ninety-foot radius reversed curve at the bottom. It has been said that the addition of the grades in a round trip gives a rise greater than the height of Bunker Hill monument (221 feet), and the summation of the curves gives 9.43 complete circles in covering the same route. The company now has 174 passenger cars operated on the multiple unit system. Each car weighs thirty-six tons when loaded with passengers and is propelled by two motors, no trailers being used. The fact that all the cars are motor cars, coupled with the unusual alignment and grade conditions, produces greater wear and tear upon the track and rolling stock than upon any other railroad in the world.

The wheels of the motor trucks are equipped with thirty-four-inch steel tires, the wheel base being six feet. The running rails weigh eighty-five pounds per yard, and the shortest radius curve is one of eighty-two feet. The wear and tear of the equipment is so heavy that the tires have to be ground practically every two weeks, about forty-eight pairs being ground per day. The life of tires is from two and one-half to three years. Tests have shown that the average energy consumption of the trains is four kilowatt-hours per car-mile.

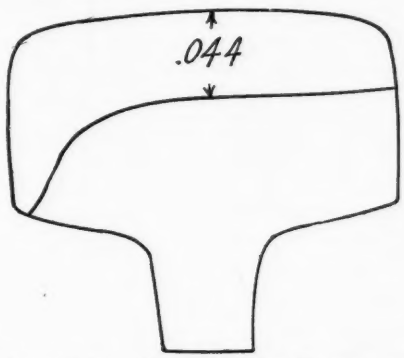
Some of the foregoing points are mentioned independently of Mr. Steward's paper, which considered only the roadbed and track. Perhaps the most striking features which the paper brought out were the heavy obstacles encountered by the road department and the methods of surmounting them. The construction details of the road vary so much from point to point that large percentage of the frogs and switches are different and can only be used at one place, which necessitates keeping at least one spare yard for each in the immediate vicinity, so that it will be instantly available in case of breakage.

Rail wear exceeds that upon any other road, although it has been notably cut down since the early days of operation. This wear occurs almost entirely upon

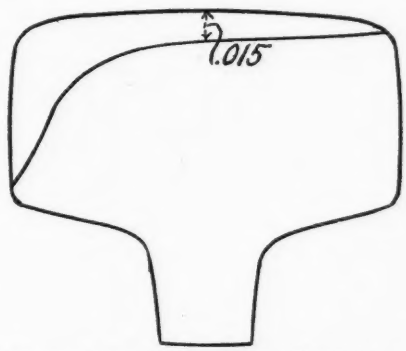
curves, and on tangents little evidence of wear is apparent. Contrary to experience with the large diameter drivers of steam locomotive, the elevated motor car drivers often cut holes in the rail in slipping or spinning around, and if the action were permitted to continue it would go on until the rail was cut in two. On curves with radii up to 500 feet the rail wears down smoothly, but above 1,000 feet radius the rail has to be removed before it is worn out on account of the waves or corrugations which form. About fifty per cent of the rail renewals are occasioned by this wavy formation, which causes a very hard and rough riding track.

Ordinary commercial rail was used first on the elevated division, but it wore out so fast on curves that the company had to specify all manner of rail compositions before a satisfactory one was found. Even to-day experiments are going on, but the wear is far less. On the shortest curve of the system—the eighty-two-foot radius at Park street—ordinary rails lasted on the average but forty-four days. That is, the depreciation was 829 per cent per annum. In this forty-four days the wear averaged from 0.6 to 0.77 inch. Finally a manganese steel rail was substituted, and after 1,000 days of service it is still doing business and shows a top wear of only about 0.016 foot—less than 0.002 inch. Although the manganese steel rail is exceedingly expensive in first cost, $5 per foot as compared with $0.38 per foot for ordinary rail, it is the most economical rail in the end. Even nickel-steel rail did not work out well. A rail of this material placed in the track at Causeway and Haverhill streets wore down 0.044 foot in 204 days in comparison with 0.015 foot wear on the hard steel rails at either side. A section of this rail is shown in the accompanying diagram. So successful has been found the manganese steel rail that the company now has about 475 feet of it in its tracks. It can readily be curved with a hand bender, although it is too hard to be cut by any tool.

Rail renewals are thus a matter of weeks or days, instead of months, as on many other roads. When rails are taken up from the elevated track they are so badly worn as to be fit for nothing but scrap. A force of twenty-five men is kept constantly at work in the night making repairs on the tracks and roadbeds between 1 and 5 A. M. Only the lightest repairs, such as replacing or tightening bolts, greasing curves, etc., can be done in the daytime. The volume of traffic and short intervals between trains absolutely prohibit any such repairs as replacing a rail or a tie. An inspection crew of eleven men is constantly walking the track, each man looking after about one and one-half miles. Compressed air from the signal pipe line, which extends along the entire route, is used whenever possible in making repairs. The company cuts, curves and drills its own rails. Even at night when no trains are operating, repair work is difficult on account of the complication of the roadbed and the limited space in which the men have to work.



NICKEL STEEL, 204 DAYS' WEAR, EIGHTY-FIVE-POUND RAIL.



CAMBRIA STEEL, 204 DAYS' WEAR, EIGHTY-FIVE-POUND RAIL—NICKEL STEEL RAIL WAS PLACED BETWEEN TWO HARD CAMBRIA STEEL RAILS.

With such facilities for the gathering of valuable data the company has been enabled to materially cut down the cost of the maintenance. Records are constantly kept and analyzed, diagrams plotted, and the whole problem of depreciation studied in a thoroughly scientific manner. The company has been most liberal in according its experience to engineers from abroad and to officials connected with rapid transit systems in this country. Although the vital necessity of keeping the track and structure safe renders it next to impossible to avoid keeping these detailed records of wear and wear, it is a source of satisfaction to every student of transportation that the company has done its utmost to maintain its equipment at the highest possible pitch of perfection. Thus, hoisting facilities, motor-driven tools, turn-tables and rails have been introduced into the repair shops, and the most advanced practice followed in every operation. There is no evidence of accumulated cobwebs in the management of the elevated division. The importance of keeping the physical part of the road in as good condition as the books and accounts seems to be appreciated. Without an enormous traffic such heavy expenditures could scarcely be maintained; but the operation of a trunk line carrying the comfort and convenience of hundreds of thousands of people upon a single pair of rails adimts of no half-hearted measures in the way of maintenance. That so much attention should be given to these matters by an operating company which is possessed of the spirit of always seeking for something better must be a satisfaction to every engineer who is striving to do broad-minded work.

American Electrical Methods.

At the annual dinner of the Newcastle section of the Institution of Electrical Engineers, says the *Mechanical Engineer,* London, Mr. R. Kaye Gray, president of the institution, referred to the recent visit of the institution to America. The Americans, he said, spoke very large. No doubt they spoke from a sound foundation, because any one engaged in electrical enterprise must know they had done a great deal of good work indeed; but the success they had obtained, he believed, was due to the fact that they had on the other side of the Atlantic large trusts controlled by men commanding large capital who, whether with good or bad judgment, developed vast enterprises. On this side they had not the same thing, or, rather, they had not the same thing to the same extent. They had only to realize the opportunities of the electrical engineer in America, when it was notorious that perhaps one success was bought at the expense of twenty trials and a large expenditure of capital. They on this side had not a large opportunity, but he would say this, that when they did put their shoulders to the wheel they did not want to have nineteen failures, but to make sure that when they did produce something it should be a development that would tell in the world. His general impression of American methods was that they were exceedingly extravagant. That extravagance was apparent to any one. He would like to say that he thought that in this country they were much wiser to carry on their experiments in a sensible way, to appropriate the experience of the people on the other side, without paying the expense.

Production and Value of Copper in the United States for the Past Ten Years.

The United States Geological Survey has issued a table showing the production and value of mineral products in the United States for the years 1894 to 1903.

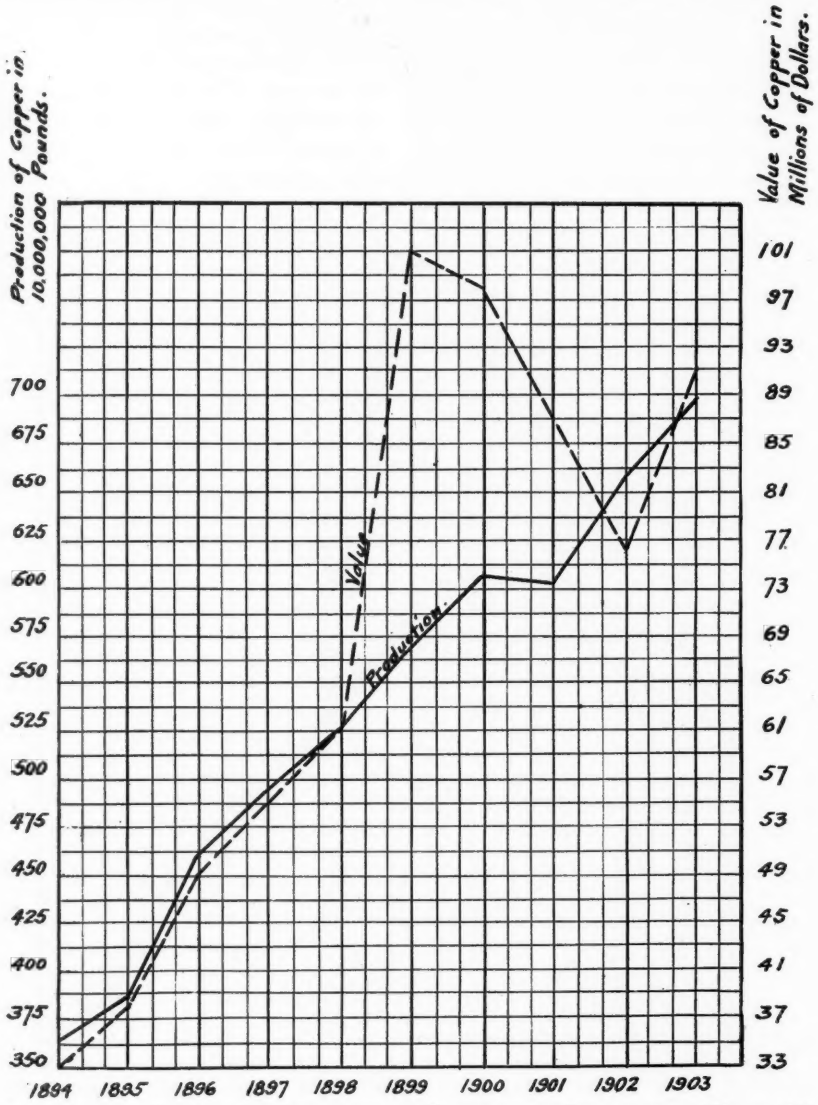


CHART SHOWING RELATION OF PRODUCTION TO VALUATION OF COPPER, FROM 1894 TO 1903.

Among numerous other products is copper, the production of which with its value for these years, is shown in the following table:

Year.	Production (Pounds).	Value.
1894.....	364,866,808	$33,141,142
1895.....	385,913,404	38,012,470
1896.....	460,061,430	49,456,603
1897.....	494,078,274	54,080,180
1898.....	526,512,987	61,865,276
1899.....	568,666,921	101,222,712
1900.....	606,117,166	98,494,039
1901.....	602,072,519	87,300,515
1902.....	659,508,644	76,568,954
1903.....	698,044,517	91,506,006

The relation of value to production is shown in the accompanying chart. It will be noted that from 1894 to 1898 the value of the copper produced and the production were closely related, while from 1898 to 1899 the value of copper increased enormously, although the production continued to increase at about the same rate as in the preceding years. From 1899 to 1900 the value dropped slightly, while the production increased as before. From 1900 to 1901 the value dropped greatly, and continued to drop until 1902. From 1901 to 1902 the production recovered, and the increase in production was at about the same rate as in the years preceding 1900. From 1902 to 1903 the value of the copper produced rose rapidly.

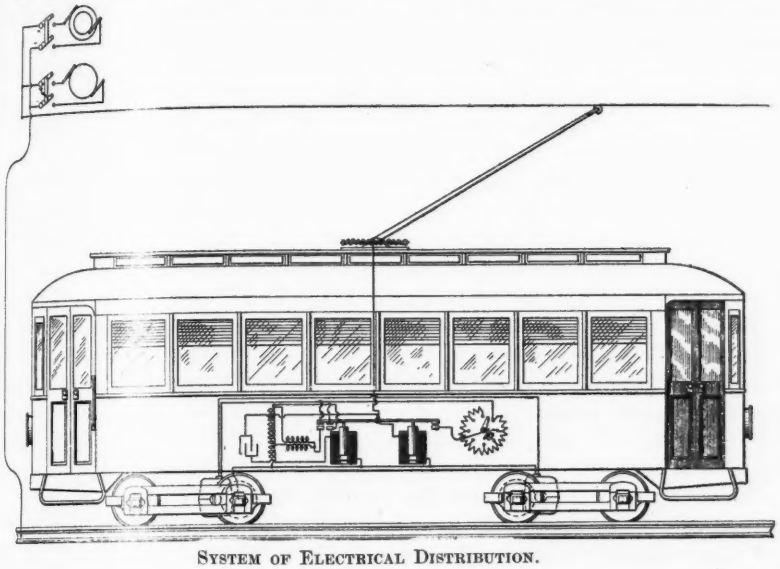
A New Decision Affecting Measuring Instruments.

The United States Circuit Court of Appeals has reversed the decree of the Circuit Court in a suit between the Weston Electrical Instrument Company, complainant appellee, and J. Franklin Stevens and Elmer P. Morris, defendants appellants. The case was brought up on appeal from a decree of the United States Circuit Court for the Southern District of New York, adjudicating the validity and infringement of claims 2, 4, 6, 10 and 12 of reissued patent No. 11,250, granted June 26, 1892; and of claim 1 of patent No. 470,340, dated March 8, 1892, both granted to Edward Weston and owned by the complainant. The opinion of the court rehearses the obtaining of a patent on November 1, 1887, by J. Cauderay, for an electric dynamometer. This apparatus included an electric meter in combination with an electrodynamometer. The court further holds that "the original Weston patent No. 433,637 describes an instrument for the measurement of alternating currents, only differentiated from Cauderay in the details shown in Weston patent No. 392,387. It describes the application of the construction shown in No. 392,387 to the movable coil of the electrodynamometer. The improvement of patent No. 470,340 consists in omitting the shellac paper frame of the movable coil of the reissued patent in suit, and in constructing it in its annular shape by winding the wire around a mandrel and cementing it together by means of an exterior coating of shellac. This construction reduced the weight of the movable coil, which was stated to be the object of the alleged invention. Other prior publications disclose similarly constructed coils, differing only in shape from that of the patent in suit in being rectangular, with rounded corners. These prior constructions were designed for use in direct-current instruments. This argument that it required invention to use such a coil, 'of any desired form,' with an alternating current, or to thus change the shape of the coil, can not be sustained, especially as it does not appear that any different or new function was accomplished by reason of such use or change. The decree of the Circuit Court is reversed, with costs, and the cause is remanded to the Circuit Court with instructions to dismiss the bill."

Mr. B. Walter has recently been experimenting with a strong magnetic field in the state laboratory of Hamburg, Germany, and has demonstrated that Rœntgen rays are not deflected by magnetic lines of force. There have been many experiments made on this question heretofore, but definite figures have seldom been given. The arrangement adopted by Mr. Walter is similar to that used by Mr. Wind in his investigations on the refraction of Rœntgen rays. The rays fall through two slots 1·74 centimetres apart onto a photographic plate 152 centimetres further off. The field poles are behind the second slot, and close to it.

Electrical Patents.

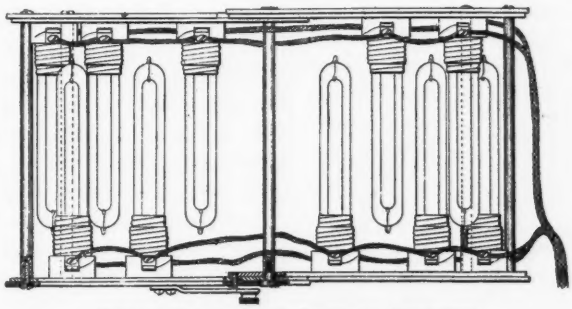
A system of electrical distribution having for its object to permit the use of either direct or alternating currents without any change in the apparatus employed except the switching of a direct-current



System of Electrical Distribution.

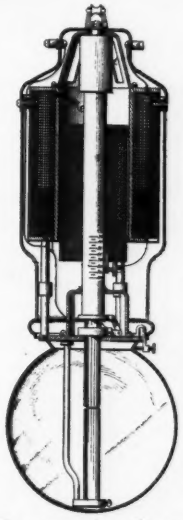
generator out of circuit or *vice versa*, according to the kind of energy it is desired to use, has been invented by Paul M. Lincoln, of Pittsburg, Pa., and the patent obtained thereon he has assigned to the Westinghouse Electric and Manufacturing Company. In the embodiment of the invention (774,764, November 15) a source of direct currents and a source of alternating currents are provided, also translating devices which are adapted for operation by currents from either source. A direct-current controller and an alternating-current controller are provided, a switch being employed for connecting either controller in circuit and disconnecting the other. The switch has two actuating magnets, one of which has a lesser degree of reactance than the other. A condenser is in series with the magnet having the lesser degree of reactance.

Walter S. Edmands, of Newton, and Charles A. Hoyt, of Boston, Mass., have assigned, by direct and mesne assignments, to Edward T. Edmands, of Newton, Mass., and June Hoyt, a patent (775,105, November 15) recently granted to them on an electric baker for surgical purposes. In the treatment of certain ailments, rheumatism, bruises, inflamed or stiff joints, etc., the part of the body which is affected is sometimes subjected to heat for the purpose of inducing or increasing circulation, stimulating secretion, occasioning or prompting absorption, or otherwise securing a return to normal functions, and thereby bringing about a relief or cure. The present invention consists of a surgical heater or baker, in which the effect of the heat is aided or enhanced by causing the heat to be applied and to act in the presence of strong and intense light, the heat and light both emanating from bodies which are embraced in an electric circuit and are rendered incandescent by the closing of such circuit. The advantage of causing the heat to act in such strong light is that by the action of heat and light combined, greater penetration of heat at a given temperature is secured than where heat is applied without light, enabling the desired results to be obtained at a lower temperature than would otherwise be effectual and also enabling better results to be attained than heretofore. The apparatus is simple and compact and is convenient for application to any part of the body.



Electric Baker for Surgical Purposes.

Ralph Scott, of Wilkesbarre, Pa., has assigned to Marcus A. Miller, of New York, N. Y., a one-quarter interest in a patent (774,789, November 15) recently granted to him on an electric arc lamp. The object of the invention is to secure in a lamp of this character an even continuous arc and the prevention of sudden making and breaking of the arc. In carrying out the invention, a vertically movable carbon tube is employed beneath which is arranged a carbon support. There is a circuit for this tube and support, in which a helix is interposed. A plunger is connected with the tube within



Electric Arc Lamp.

the helix, and a lug projects laterally from the tube. The lower end of the tube is enclosed within a housing, extending in the path of movement of the lug. The tube carries a clutch which is adapted to be released by the longitudinal movement of the tube.

English Telephone Facilities.

An experiment, the issue of which will be watched with marked interest, writes Joseph G. Stephens, consul, Plymouth, England, is just now being conducted by the postal-telegraph authorities. Its object is to ascertain how far it may be possible to make village post offices serve the further purpose of public telephone-call offices. Six villages have been selected, and in these any one may now ring up a subscriber and communicate with him by telephone at the ordinary rates, which in this district amount to twelve cents for a three-minute conversation. If the person with whom communication is sought does not happen to be on the telephone list, the sender may telephone his message to the nearest post office and have it delivered thence by express messenger. In the opposite direction—that is, from town to village—similar facilities will be available.

Reviews of Current Engineering and Scientific Literature.

The Murray Typewriting Telegraph Used by the British Post Office.

The Murray high-speed typewriting telegraph, after eighteen months' trial between London and Edinburgh, is now being brought into general use by the British post office. The system is similar to the Wheatstone system, but the characters are written at the transmitting station on a keyboard similar to a typewriter. These characters are in the form of punch marks on a continuous paper strip. The Beaudot alphabet is used, which consists of various combinations of holes up to the number of four in five positions. The tape, after being punched, is passed through a Wheatstone transmitter, and the holes are reproduced at the receiving station on another tape. This second tape is passed through an ordinary typewriting machine provided with a device which translates the groups of holes into letters, the message being typewritten in page form. The speed at which the punching machine can be worked is limited by the skill of the operator. The transmitter can deal with the tapes produced by four or five punching machines. At the receiving end the speed is limited by the capacity of the typewriter. The practical limit appears to be a little over 700 letters per minute, although 900 letters a minute have been written on occasion. A trunk line carrying a message sent out by one transmitter can be tapped at any number of places desired.—*Abstracted from the Mechanical Engineer (London), November* 12.

Chlorate and Perchlorate.

One of the favorite methods of forming accumulator plates quickly is that due to Lucas, in which sodium perchlorate plays an important part. In general, it may be assumed that the best substances for assisting in quick formation are those bodies which either do not change during electrolysis or the changes of which are easily controlled. Hence, one may expect that inorganic bodies will be more favorable for producing quick formation than organic bodies. Another important feature of the substance used for quick formation is its purity. Bearing these facts in mind, it seemed to Dr. Schmidt-Altwegg that potassium chlorate might be very effective in hastening the formation of lead plates. Experiments were conducted to determine whether this was so. The plates were formed in an electrolyte of 0.06 specific gravity, which consisted of chemically pure sulphuric acid mixed with distilled water, and containing one per cent of potassium chlorate. The current density was 0.413 ampere per cubic decimetre of exposed surface. The charge lasted uninterruptedly for twenty-four hours, after which the plates were charged in the opposite direction at the same rate for an equal length of time. The plates were then removed, carefully washed, and set up as positive plates in a cell. They were finally charged for sixty hours at the rate of 0.413 ampere per square decimetre of surface. Following this charge they were discharged at the rate of 0.226 ampere per square decimetre of positive plate. It required twenty minutes to discharge them. Upon reformation the voltage upon discharge fell to the same point after fifty minutes, and after a third charging, two hours were required to reduce the voltage to the same point. The voltage at the end of the discharge in each case was 1.83.—*Translated and abstracted from Centralblatt für Accumulatoren (Gross-Lichterfelde-West), November.*

Electrolytic Corrosion of Water Pipes at Bayonne, N. J.

The authorities of Bayonne, N. J., some months ago employed Mr. A. A. Knudson, of New York, to investigate the effect of electrolysis on the water mains of that city. Mr. Knudson made a very complete investigation, taking voltmeter readings, which were commenced at the northern end of the city and covered all the street railway lines. All of the tests between the mains and the rails showed the mains negative to the rails, the current leaving the tracks and taking the mains in all the streets of the city where they parallel. He found that there was no "positive area" in the city, in the sense of mains positive to rails. This is due to the fact that the power-house is located in Jersey City, some five miles from the central part of Bayonne. On one line, differences of potential of as high as twenty-five volts were found. As a result of the measurements, it was found that there were two paths by which the returning current reaches the power-house. One of these paths was by water mains passing into Jersey City, some of the current going by the twenty-inch main which crosses the canal bridge at avenue D and connects with the main in Jersey City, and some going by way of the large supply mains which pass into Jersey City further to the west. The second path was by the way of the water mains to the shore and thence through the waters of New York and Newark bays to the power-house which is located on marshy ground near the shore. The most important break was in the twelve-inch main in East Twenty-second street. This main burst during the night of August 6, 1904, and some four million gallons of water were lost before the leak was repaired. Tests made showed that current was passing from the main to the soil at the point of the break. An average current of about 16.5 amperes passed out of the main into the marsh for about two hours during the heavy traffic of the evening, and similarly for about two hours during the early morning traffic. During the remaining twenty hours of the day, the current at this point varied according to the number of cars on the line. Another place at which a break occurred was in a main in First street. This is a six-inch main which is reached by tidewater. The main was found to be positive to the soil. The flow of current through the main was west with a variation of from 5.2 to twelve amperes. Numerous other tests were made at points where mains were broken. All the damage to the water mains in the city caused by electrolysis was due to the fact that the railway current passed out of the mains to the tidewater soil. No case was found where it passed back to the rails. The remedy for electrolysis of the water mains rests with the street railway corporation. There are other ways than ground returns to bring the currents back to the power-house in Jersey City. As long as a ground return is used, so long will the currents find their way to the mains and pass out of them in the manner described. The full extent of damage by electrolysis to the water mains in Bayonne will not be known until those in the marshes and the water front have been removed. In many cases, it is impossible to examine these mains.—*Abstracted from Engineering News, November* 17.

Wireless Telegraph Portable Stations for Military Use.

Wireless telegraphy as a means of communication between parts of an army in the field offers some advantages over the

older methods of electrical communication. Communication can be kept up continuously, even while on the move, and the troubles of maintaining in working condition a temporary line of wire are eliminated. In this article Dr. Alfred Gradenwitz describes the portable wireless telegraph equipment constructed by the Gesellschaft für Drahtlose Telegraphie, Berlin, Germany. This apparatus does not differ very materially from the other equipments for a like purpose which have been described. The details are, however, of interest. The system is designed to operate with two wave-lengths, one of 350 metres and one of 1,050 metres, the same antenna being used in each case. For the shorter wave-lengths, the antenna oscillates in three-quarters of a wave-length, and for the longer waves in one-quarter of a wave-length. It is adjusted in each case by an auxiliary capacity of about six square metres of metallic copper, inserted at a height of one metre above the ground for the shorter wave-length. For the second case the surface is about twenty-four square metres. The antenna is supported by a balloon with a volume of ten cubic metres, or by silk kites with an effective surface of 1.1 square metres. The lifting force is three kilogrammes for the balloons. Each station consists of two carts, one carrying the generating machinery, which consists of a gasoline engine driving directly a one-kilowatt alternator and a small exciter. The engine is cooled by water circulated by means of a small pump. On the other cart are mounted the sending and receiving devices. The high-tension apparatus is enclosed, so that it can not be touched accidentally. All of this apparatus is placed in the front part of the cart, the receiving and registering devices being placed in the rear. The gas for inflating the balloons is carried on in this cart in reservoirs with a capacity of five cubic metres, in which the gas is stored at a pressure of 120 atmospheres. —*Translated and abstracted from the Revue Pratique de l'Electricité (Paris), November* 5.

The Testing of Transformer Iron.

The best way of measuring the losses taking place in transformer iron is believed by Mr. Lancelot W. Wild to be by means of a wattmeter. Some precautions are needed, however, in order that accurate results may be obtained. It is generally assumed that the hysteresis loss varies directly as the frequency and as the 1.6 power of the induction. While, theoretically, eddy current losses are assumed to be proportional to the square of the induction, the square of the frequency and the square of the thickness of the plates, this loss is not verified by actual tests, due, probably, to the effect of the self-induction of the eddy currents themselves. It is found that the total iron loss varies at less than 1.6 power of the induction. Sometimes it is even as low as 1.4 power. If the hysteresis loss varies, as is generally assumed, the eddy current loss must vary by something less than the square of the induction. It is also found that the eddy current losses are proportional to something less than the square of the frequency. The same is probably true of the effect of the thickness of the iron sheaths. In making measurements by means of a wattmeter, it is desirable to eliminate from the measurement the loss of the wattmeter itself, and the loss due to the resistance of the transformer windings. The best arrangement of wattmeter connections is one which includes the loss due to the pressure coil, rather than that due to the current coil of the instrument. The method of testing iron found most satisfactory by Mr. Wild consists in building up a square magnetic circuit of rectangular stamping, arranging these in a form so as to break joints. On the circuit thus arranged three coils are placed. One of these is connected to a static voltmeter, the indications of which determine the induction through the iron. The shunt coil of the wattmeter is connected across a second coil, which serves as the secondary, while the series coil of the wattmeter is connected in series with the primary winding. By this arrangement the copper loss in the primary winding is eliminated from the wattmeter reading, while the shunt coil is easily calculated by the ratio of the windings, the reading on the voltmeter, and the known resistance of the shunt circuit. Another advantage is that, by varying the windings, the wattmeter constant can be varied to obtain good readings on the instrument under all conditions. At the Westminster electrical testing laboratory, where this method is in use, there is a set of standard coils wound on square bobbins permanently fixed on a wooden base. There are six voltmeter coils, three wound with 2,000 turns each, and three with 500 turns each. The coil for the shunt of the wattmeter consists of twenty turns. The primary coil consists of two turns only, and carries up to fifty amperes. The wattmeter is of the reflecting pattern, with 160 ohms in series with its shunt coil. With the above arrangement it reads up to eleven watts. The strips of iron are seven inches long and one inch wide. Before commencing a series of tests, the physical dimensions of several samples should be determined. In obtaining a mean cross-section, the micrometer is unsatisfactory, it being better to deduce this by means of the weight of the sample and its specific gravity.—*Abstracted from the Electrician (London), November* 11.

The Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board's Scheme.

This system, part of which was recently put into operation, is the first of its kind in England. A large, modern generating station was erected at a suitable point of the district, which lies near Manchester, England, and from this station is supplied electrical energy for light, for power to be used in mills running in the district, and for operating an important electric railway system. The general plan is to generate electrical energy at 6,000 volts, and to transmit this to four substations, where it is to be transformed down and distributed locally as direct current at different voltages. In equipping the station, English practice has been followed, the generators being directly driven by means of vertical, triple-expansion, compound Corliss engines, rated normally at 815 indicated horsepower. The generators are three-phase machines, giving 6,000 volts, forty cycles, the normal output being 500 kilowatts. The plant is equipped with Lancashire boilers constructed for a working pressure of 180 pounds per square inch. Two fuel economizers have been installed, the arrangement being such that they can be run in series or in parallel, or singly, or both cut out. A typical substation equipment consists of two switchboards, one for high tension, and the other for low tension. There are in each two 200-kilowatt, synchronous motor-generator sets, space being available for two additional units. There are also a balancer set, consisting of two direct-current machines connected across the three-wire distributing system and driven by an induction motor, and a booster driven by a forty-five-horse-power, direct-current motor, used for controlling the battery, which consists of 135 cells, the latter having a discharge rate of 750 amperes. The synchronous motor-generators operate off the high-tension lines. The direct-current machines can be run either as shunt machines or compound machines, the former method of operation being used when supplying the lighting network, and the latter when supplying power for the railways. The generating station equipment at present is three main units. The railway consists of about twenty-one miles of single track.—*Abstracted from the Electrical Review (London), November* 11.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Le Chatelier Pyrometer.

The W. C. Heraeus Platinum Works, Hanau, Germany, manufactures the Le Chatelier pyrometer, which is shown in the accompanying illustrations. It is constructed in accordance with the specifications of the Royal Physical Technical Institute, at Charlottenburg, and meets all modern requirements. The principle involved in the construction of the instrument is the conversion of heat to electric current, and determining the degree of heat by a suitable device which indicates the electromotive force of the current.

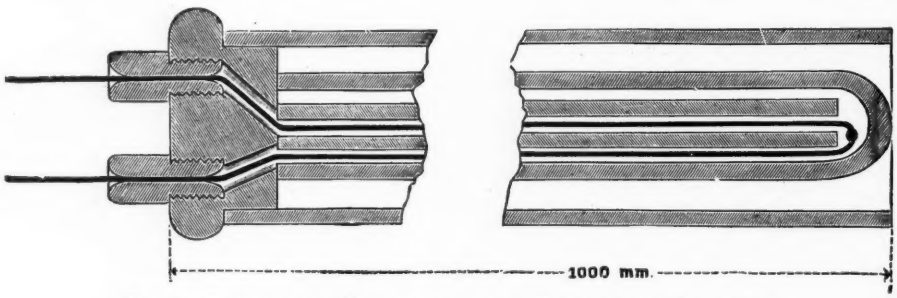
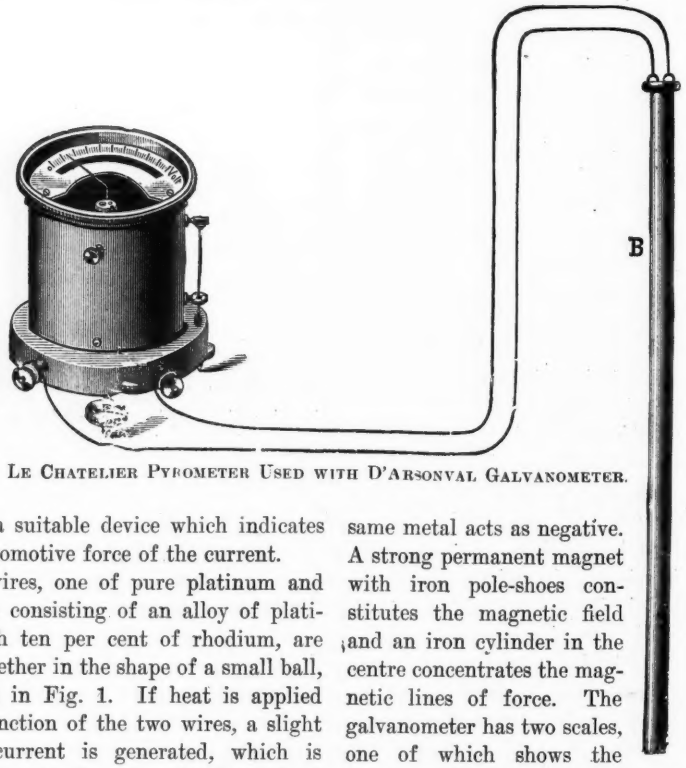


FIG. 1.—DIAGRAMMATIC REPRESENTATION OF LE CHATELIER PYROMETER.

Two wires, one of pure platinum and the other consisting of an alloy of platinum with ten per cent of rhodium, are fused together in the shape of a small ball, as shown in Fig. 1. If heat is applied to the junction of the two wires, a slight electric current is generated, which is proportional to the amount of the heat applied. To prevent injury to the wires from any cause whatever, they are enclosed in porcelain tubes. A small tube, open at both ends, insulates the two wires; and a larger one, closed at one end, covers both wires and the tube. These tubes will resist a temperature as high as 2,920 degrees Fahrenheit (1,600 degrees Celsius), and are made up to fifty inches in length. The extremities of the two wires are connected to a galvanometer of the d'Arsonval type.

The current is transmitted to an armature wound in quadrangular shape through a fine wire of hard metal which is non-oxidizable. A small spring of the same metal acts as negative. A strong permanent magnet with iron pole-shoes constitutes the magnetic field and an iron cylinder in the centre concentrates the magnetic lines of force. The galvanometer has two scales, one of which shows the electromotive force in microvolts, and the second scale shows directly the temperature. The object of the microvolt scale is to allow checking of the readings of the instrument.



LE CHATELIER PYROMETER USED WITH D'ARSONVAL GALVANOMETER.

A thumb screw is provided on the casing of each instrument, and secures the armature, thus avoiding the breaking of its suspension wire while in transit. The adjusting screws in the base allow the instrument to be placed in a horizontal position. A switch on the base of the galvanometer is used to break the thermo-current.

When the instrument is in use the end of the tube containing the two wires is exposed to the substance whose temperature is to be measured, and the free ends of the wires are connected to the binding-posts of the galvanometer, as shown in Fig. 2. If desired, the galvanometer can be placed at any distance from the source of heat, and the current conveyed to it by means of insulated copper wires. When the temperature of the thermo-electric-couple has risen to that of its surroundings, the deflection of the pointer of the galvanometer will cease.

Mr. Charles Engelhard, 41 Cortlandt street, New York city, is the agent for this pyrometer in America.

A Severe Test for Engine-Type Generators.

Three Westinghouse sixty-two and one-half-kilowatt, engine-type generators, which have been in service in the basement of the New England Building, Cleveland, Ohio, for some time, have recently been subjected to a test which reflects a great deal of credit upon their construction. A fire occurred in the basement where the generators were installed, completely burning away the insulation on the outside of the field coils. The fire department played upon these machines with six lines of hose for about an hour. Within an hour after the time the water had been turned off, one of these machines was in operation, carrying its full rated load. The second machine was put in operation later and carried its full rated load, and at the present time two of the machines are operating under the load normally carried by all three of them. The fireproof insulation of the field coils withstood the fire, even though the outer protecting covers were entirely consumed and the heat was so intense as to burn and blister the finish on the frames.

A New Joint for Stranded Wires.

Dossert & Company, 59 Fulton street, New York city, have recently placed on the market a new form of joint for stranded wire. The object of the joint is to join together two stranded wires cheaply, and yet make a joint that is as good as the wire itself. The type B joint consists of seven parts, which are shown in Fig. 1. These parts consist of two compression nuts A; two outside rings B; two inside rings C, and a nipple which may be two, three or four-way, as required. In making up the joint the wires are stripped for a length equal to that of the compression nut, and the compression nut and the outside ring are slipped over the end. The inside ring is placed around the central core of wires and driven home by means of a steel tube or other convenient tool. The outer wires are then brought together so as to allow the nipple to be slipped over them, and the compression nut is screwed up on the nipple.

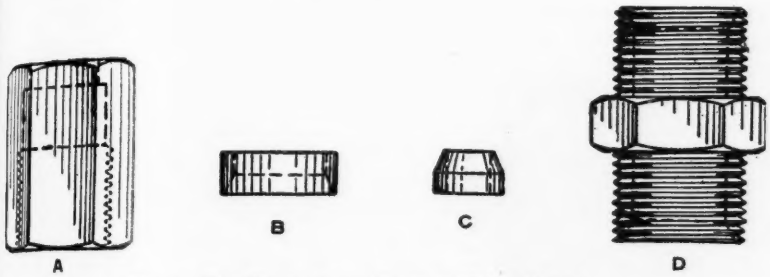


FIG. 1.—THE ELEMENTS OF DOSSERT METAL JOINT.

The completed joint is shown in Fig. 2. An hexagonal tube is slipped over the finished joint and taped in place so that the parts can not become unscrewed.

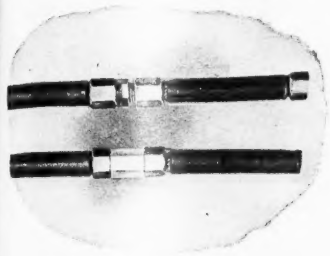


FIG. 2.—A FINISHED JOINT.

A 1,000,000 circular mil joint is shown in Fig. 3. Fig. 4 illustrates a comparison of the Dossert joint and the ordinary soldered joint. The soldered joint is very clumsy as compared with the Dossert joint, and is much more expensive to make, as the time of two men, sometimes for a number of hours, is necessary, and a large amount of solder must be used. In making up a Dossert joint, one inexperienced man can complete it within ten minutes.

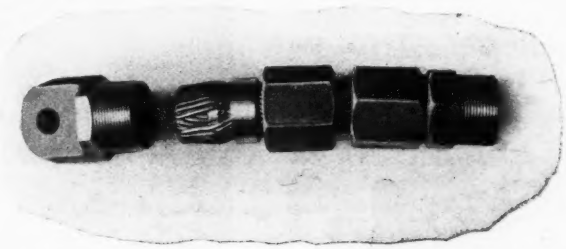


FIG. 3.—JOINT AND LUG FOR LARGE CAPACITY CABLE.

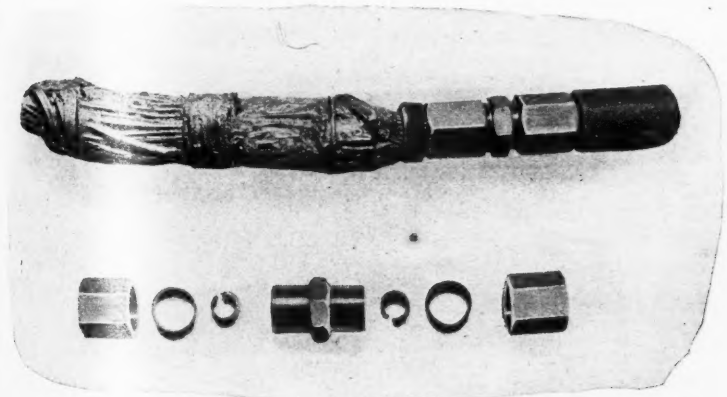


FIG. 4.—COMPARISON OF SOLDERED JOINT AND DOSSERT JOINT.

Fig. 5 shows a four-way connection as made up with the Dossert joint. It has been found that the conductivity of the Dossert type-B joint, under the milli-voltmeter test, varies from seventy to ninety per cent of an equal length of the wire that it unites. The conductivity of the type-C joint, which is not shown, has been found to be greater than that of an equal length of wire.

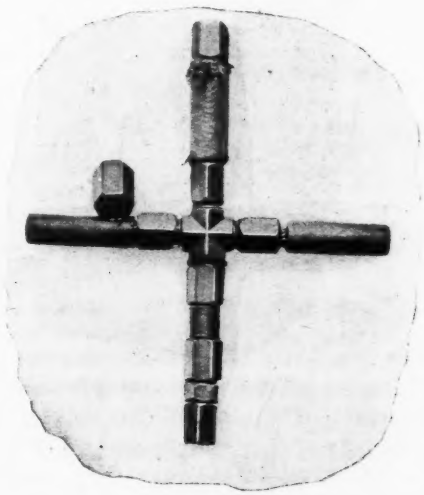


FIG. 5.—FOUR-WAY CONNECTION.

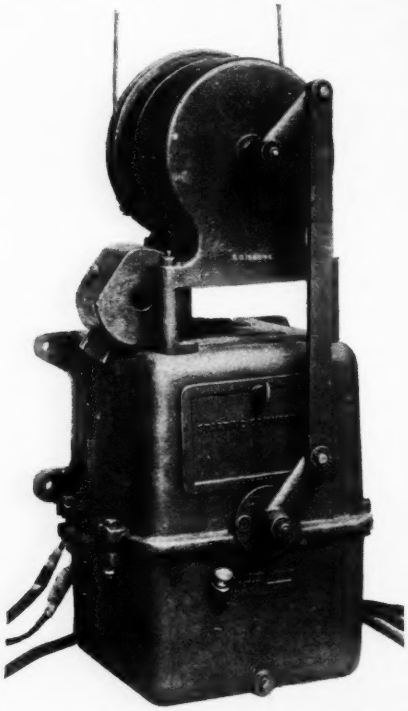
Telephone Company Establishing a Multiple-Tap Cable System.

The Elyria Telephone Company, Elyria, Ohio, is building its new multiple-tap cable system. The company has installed several thousand feet of underground cable and more than 100,000 feet of aerial cable. A new multiple, common battery switchboard of the central energy type has been recently installed. It is the intention of the company to provide several kinds of service, such as individual service, party-line service and measured service, which will apply both to business and residence telephones.

The engineering and management of the plant is under the supervision of L. W. Stanton, of Cleveland, Ohio, and Chicago, Ill.

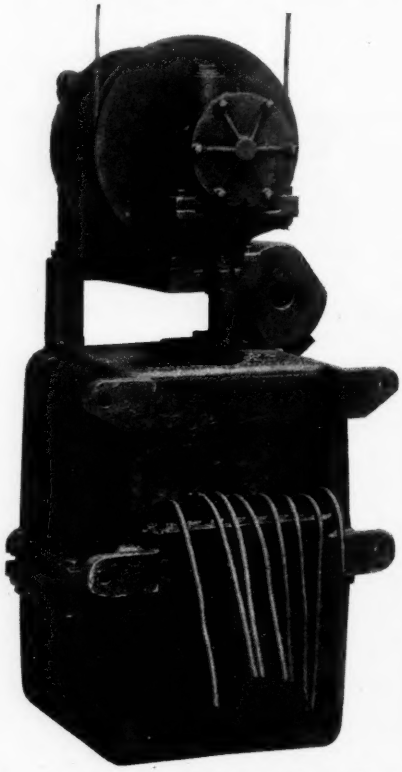
Automatic Pump Controller.

The Westinghouse Electric and Manufacturing Company is putting on the market a new automatic pump controller which is shown in the accompanying illustrations. The controller is designed for use with the Westinghouse type C polyphase motors of from five to fifty horsepower. Whenever the water in a tank falls below any predetermined level, the controller automatically starts the pump, and when the water reaches a certain depth automatically stops it. The controller consists of a combination of ropes and levers connected with a float and a tank, and the starting lever of the device together with a Westinghouse oil-immersed autostarter and a starting and stopping mechanism connected by a link shown in the photograph, and governed by a weighted lever. The lever moves through an arc of about 140 degrees in a slot in the drum of the automatic device. It falls through this distance when the float has turned the drum so as to lift



Automatic Pump Controller, Front View.

the weight past the vertical position. As the water level falls, it lowers the float which turns the drum and lifts the weight until it reaches an upright position; it then falls through 140 degrees, throwing the handle to a full running position and starting the pump. The rising water causes the float to turn the drum in the opposite direction, and the weight is lifted until it falls into its original position, thus throwing the handle to the off-position and stopping the pump. The falling weight is checked by a dash-pot which is adjustable so as to regulate the speed. The lever moves slowly upon its shaft, and in falling compresses two helical springs which are coiled loosely on the shaft and press against the casting keyed



Automatic Pump Controller, Rear View.

to it. This casting is prevented from turning by a pawl held by notches in the main casting. The weight arm or lever compresses the springs and drops the pawl on which the springs move to the next notch. During the downward movement of the weight the pawl is dropped three times, and at each dropping it allows the shaft to be turned a certain distance by the compressed springs and the autostarter is thrown through the three notches, starting or stopping the motor. The Westinghouse company does not furnish any of the float mechanism but simply supplies the controller.

Exhibit of James Clark, Jr., & Company, St. Louis, Mo.

James Clark, Jr., & Company, Louisville, Ky., have an interesting exhibit at the St. Louis Exposition, of motor-driven machine tools. A number of the tools exhibited are shown in the illustrations. Fig. 1 shows a radial drill, which is a new departure in the application of

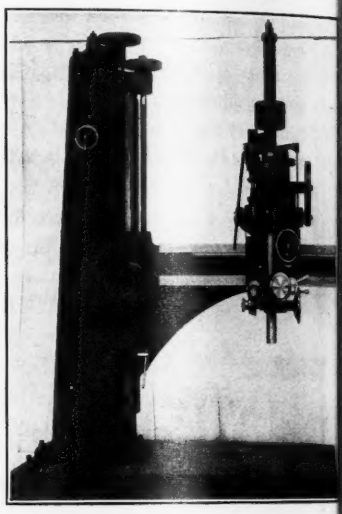


Fig. 1.—Motor-Driven Radial Drill.

motors to machine tool-driving. A special variable-speed motor is incorporated into the design of the machine itself instead of attaching a motor to the machine through a combination of belts, gears or

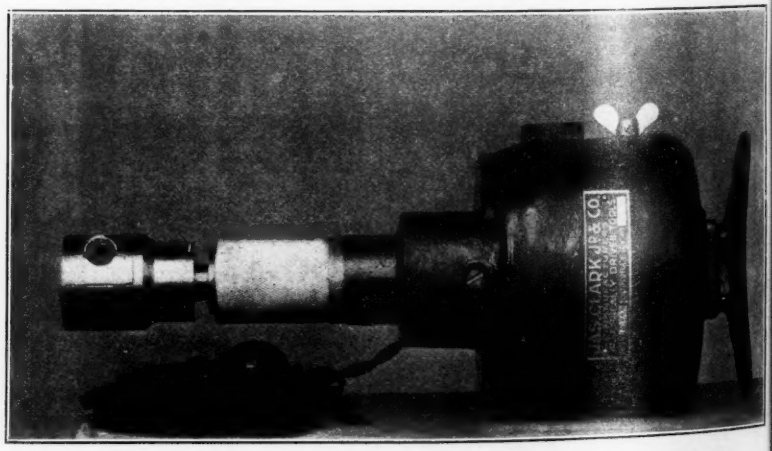


Fig. 2.—Motor-Driven Breast Drill.

speed boxes. The driving motor and controller are built into the head of the machine, and the motor is geared directly to the spindle. The motor has nine speeds which give in connection with the back gears eighteen spindle speeds. The back

gears are of the friction type, and can be thrown in or out without stopping the machine. The spindle is provided with a reverse for tapping, which can also be operated without stopping the machine.

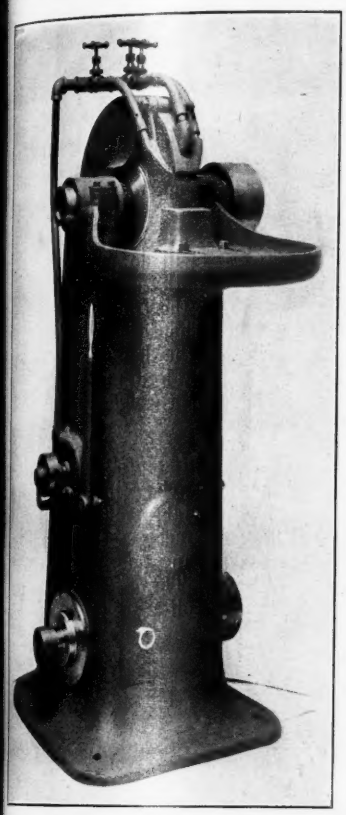


Fig. 3.—Motor-Driven Water Grinder.

The spindle has a quick return, depth gauge, automatic stop, and eight positive

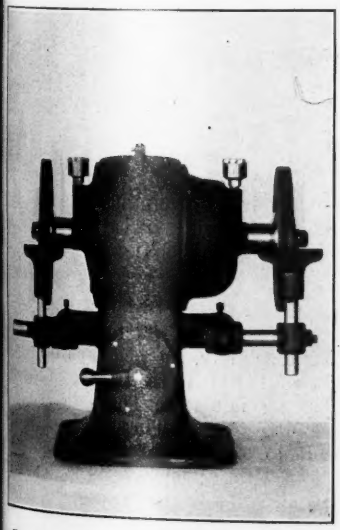


Fig. 4.—Motor-Driven Bench Grinder.

speeds from 0.006 to 0.062 inch per revolution, in geometrical progression. The arm is raised and lowered by a series-wound motor in the top of the column. The motor is directly geared to the hoisting screw and controlled by the small handle on the side of the column.

They also exhibited a portable electric breast drill shown in Fig. 2. The drill can be driven at a much higher speed than is possible by hand, and is run by a one-eighth-horse-power motor at either 110 or 220 volts.

The electrically driven water-tool grinder shown in Fig. 3 has a driving motor and controller encased in the lower part of the column where it is protected from heat and moisture. The frame which is cast in a single piece contains seats for the wheel bearings, a water reservoir and magnet frame of motor. A small centrifugal pump driven from a pulley on one end of the motor shaft delivers a supply of water, which by means of adjustable nozzles can be directed wherever it is needed. The motor is four-pole, and wound for 110 or 220 volts, direct current.

At the exhibit, there is shown in operation a nine-kilowatt motor-generator which takes current from the 500-volt mains of the exposition and supplies the exhibit with 220-volt current. All of the machines are connected so that they can be shown in operation.

There are several standard small motors shown, and also a variable-speed motor designed especially for direct connection to machinery. This motor has two commutators and two armature windings having a ratio of five to three, giving three primary speeds. For the lowest speed, these windings are run in series. Higher speeds are obtained by running them singly. The intervening speeds between the primary speeds are obtained by inserting resistance in the field circuit.

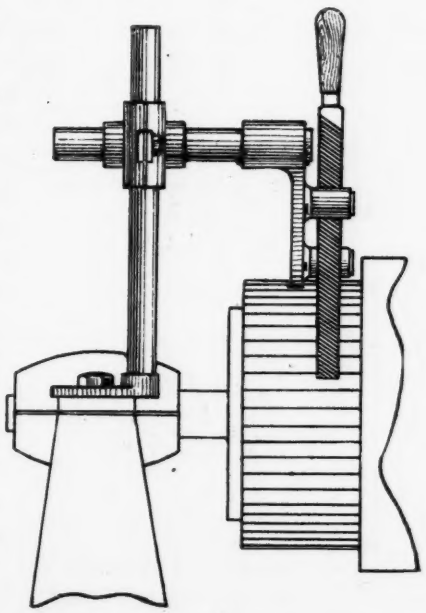
Among other machinery exhibited are two twelve-inch sensitive drills, one with a constant-speed open motor driving the spindle through a variable friction, and the other with a variable-speed motor mounted directly on the spindle; a floor drill; a centre grinder; and a bench grinder which is shown in Fig. 4.

Winter Cruises.

The Hamburg-American line, 35 to 37 Broadway, New York city, is distributing some attractive literature calling attention to winter cruises to summer lands. The tours outlined in this literature carry travelers upon the waters of the Atlantic, and the Mediterranean, the Adriatic and the Caribbean seas. A new series of short and inexpensive cruises starts from Genoa and Venice. Various services established by this line afford excellent connections between New York and the other starting points. Supplementary to the various cruises proper, interesting side trips have been arranged. These may be taken or omitted, at the option of the traveler.

Filing Device for Truing Commutators.

The Excelsior Machine Works, Akron, Ohio, is manufacturing a filing device for the truing of commutators. This device is shown in the accompanying illustration. The principal part of the machine is a standard, which is provided with a foot, by means of which it can be attached to the bearing of the motor or generator. This standard carries a horizontal bar, which may be clamped at any desired height. The bar carries a file-holder, which may be moved across the face of the commutator. The cutting tool is an ordinary file, held in the proper position

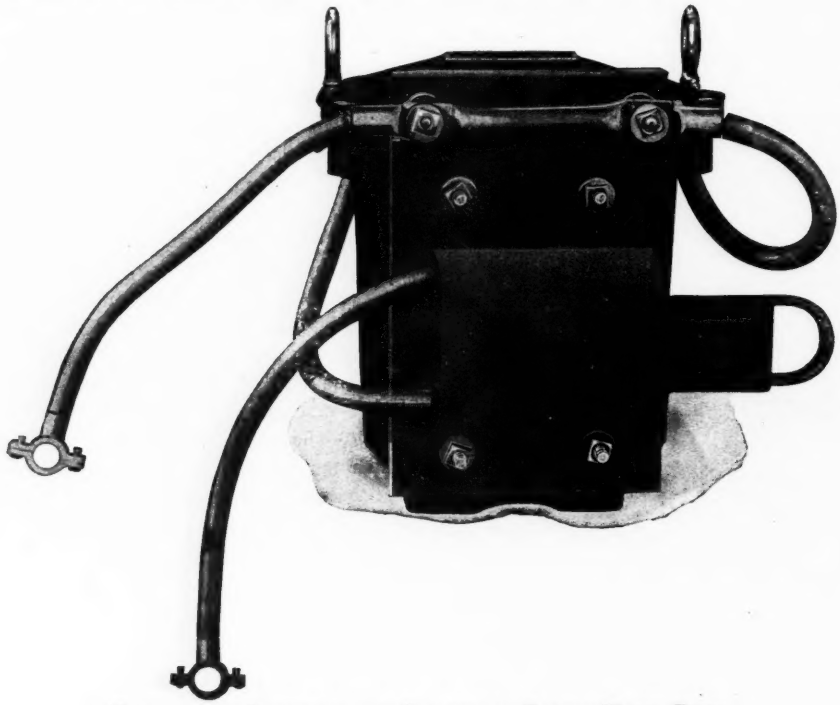


Filing Device for Truing Commutators.

by means of the file-holder. The file rests on two pins, one of which is slotted and so located as to steady the file without the possibility of chattering. The file, as it is moved back and forth over the commutator, cuts to a uniform depth, thus leveling the surface lengthwise and restoring the true cylindrical form. The commutator may be readily smoothed off as soon as the surface begins to show any signs of wear, and before it has become uneven enough to warrant the removal of the armature or the amount of metal that would ordinarily be taken off by means of a cutting tool.

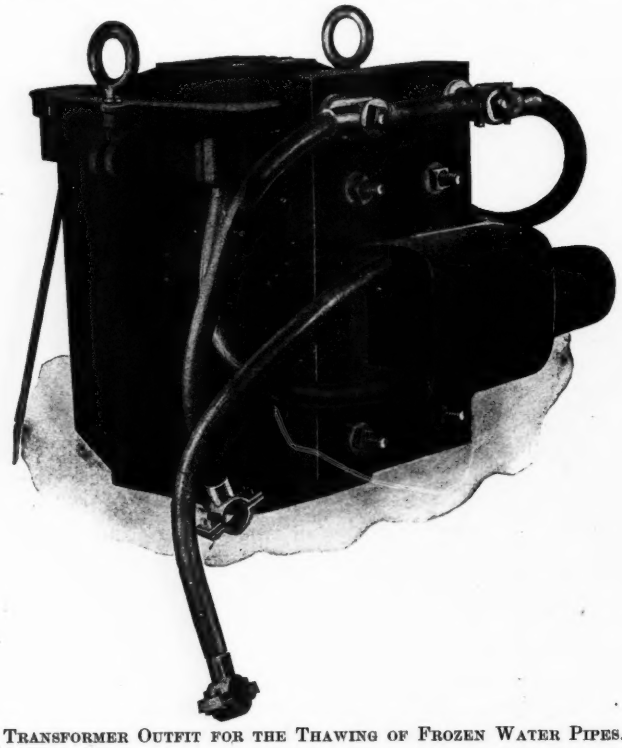
The Use of Electric Current for Thawing Frozen Water Pipes.

Within the past two or three years considerable use has been made of the heating effect of the electric current for thawing frozen water mains. The large public service corporations supplying electricity have done a great deal to promote the use of electric current for this purpose. Where the connection is at all possible—and there are very few instances where it is not possible—the thawing of a frozen water main is accomplished very quickly and with the entire elimination of the distressing conditions which hitherto were involved in such an operation.



TRANSFORMER OUTFIT FOR THE THAWING OF FROZEN WATER PIPES.

The Pittsburg Transformer Company, Pittsburg, Pa., has designed a transformer and thaw outfit for the special purpose of thawing frozen water mains. The outfit consists of a transformer adapted to operate on any circuit of approximately 1,100 or 2,200 volts, and 60 or 133 cycles. The transformer will deliver a current of 300 amperes continuously, or currents of about 600 amperes for periods of half an hour.



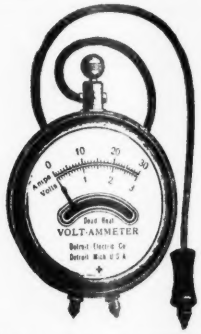
TRANSFORMER OUTFIT FOR THE THAWING OF FROZEN WATER PIPES.

Upon the back of the transformer are mounted a heat indicator and a choke coil. The heat indicator consists of a section of lead pipe connected in series with the transformer, and the temperature which this assumes is a guide as to the heating of the pipe under treatment. The choke coil consists of a few turns of heavy copper bar with a movable laminated iron core. When this plunger is pushed into the coil the transformer secondary may be short-circuited, but no more than normal current will flow.

The object of the apparatus is to send current through the frozen section of pipe. One secondary should be connected to the pipe inside of the house, and the other lead to a near-by hydrant outdoors, or to a pipe inside of a neighboring house.

A Portable Volt-Ammeter.

The accompanying illustration shows the form of portable volt-ammeter which is being manufactured by the Detroit Electric Company, 56 Shelby street, Detroit, Mich. There is a large demand for a portable volt-ammeter which can be depended upon for reliability. The manufacturer states that the construction of this instrument is such as to enable it to guarantee accuracy in service. The instrument has no delicate parts, and is constructed with great rigidity. It is entirely self-contained, and is suitable for every class of battery, launch and automobile work.



PORTABLE VOLT-AMMETER.

Christmas Tree Receptacles.

William Roche, 52 to 54 Park Place, New York city, has placed on the market a useful Christmas tree receptacle for adapting miniature lamps to Christmas tree decoration. These receptacles are made to take any of the standard miniature battery lamps. The socket is finished off with a copper brad, which is sharpened so as to be inserted at any part of the tree. Two fine copper wires are attached to the copper terminal and the socket shell, these wires being silk-covered and affording opportunity for great flexibility in manipulation. Directions and estimates will be furnished upon application.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

THE CANADIAN NIAGARA POWER COMPANY expects to generate power during the present week. One of the six 10,000-horsepower turbines will be run. This is the first of the three powerhouses being built on the Canadian side of the Niagara river to start operations.

THE OLD COLONY STREET RAILWAY COMPANY is to remove its power plant which is at present located in Rehoboth, Mass. The company is centralizing its power plants and besides the Rehoboth plant, the ones in Bridgewater and Taunton will be discontinued. The central plant will be established at Quincy.

NAVY WIRELESS STATIONS—Orders are being prepared opening to commercial business the following naval wireless telegraph stations: Portsmouth, N. H.; Cape Ann, Mass.; Boston and New York navy yards; Cape Cod; Montauk, L. I.; Navesink, N. J.; Cape Henry, Va.; Dry Tortugas, Fla.; San Juan, Culebra; Yerba Buena, Cal., and Mare Island navy yard. Other stations will be opened in a few weeks.

SOUTHERN PACIFIC RAILROAD CONSIDERING ELECTRICITY FOR SUBURBAN SERVICE—It is announced that the Southern Pacific Railroad is considering the use of electricity as a motive power on its suburban lines. The road has been securing bids on various types of electric locomotives, and it is said that a satisfactory one has been secured. Plans for converting the local lines to Berkeley, Almeda and Oakland have been completed for some time, although nothing has yet been done in the line of actual work.

ELECTRIC RAILWAY FROM SAN FRANCISCO TO SANTA ROSA—Surveyors have been busy for some time mapping out the route of a road from San Francisco to Santa Rosa. This will be a continuation of the Petaluma, Sebastopol & Santa Rosa electric road, which now runs to San Pedro. Actual construction work will be commenced early next year, and it is expected that the road will be completed within a short time. The new road is to be high-speed, and is intended to compete with the California & Northwestern for the passenger patronage to Santa Rosa.

MUNICIPAL LINES IN MICHIGAN ARE MERGED—Articles of consolidation and merger of the Negaunee & Ishpeming Street Railway and Electric Company with the Negaunee Gas Light Company have been received by the register of deeds of Marquette County for record. The new corporation will be known as the Marquette County Gas, Light and Traction Company and will be capitalized at $400,000. The directors are: Thomas A. Rockwell and Thomas B. Clerk, of Evanston, Ill.; George A. Rockwell, of Oshkosh, Wis.; John H. Bryant, Jr., of Chicago, and E. B. Finch, of Ishpeming.

ELECTRIC PLANTS WANTED IN EUROPE—The municipality of Barcellos, Portugal, has offered a thirty-year concession for the erection of an electric light and power plant. The company must furnish the town with 160 sixteen-candle-power incandescent lights and six fifty-candle-power arc lights for $1,620 a year. The borough of Rochdale, Lancashire County, England, is planning to spend $200,000 in enlarging and improving its electric plant. East Retford, Nottingham County, England, a place of over 10,000 inhabitants, is contemplating the building of a municipal electric light and power plant.

PLAN A NEW ELECTRIC LINE IN WASHINGTON—Investigations of traffic and other conditions at Mabton, Wash., have been carried on with a view to generating electric power at Rocky Ford, on the Yakima river, three miles from there, to operate a line from Mabton to Sunnyside and the Outlook country, and also to furnish power for flour mill and other purposes, and to pump water to a reservoir on the hills to the south of the town for irrigation purposes. The water right and the land adjacent have been purchased. The river at this point falls about nine feet in 300, and ample power can be generated for the purposes named.

BELT LINE PROJECTED TO TOWNS IN THE GENESEE VALLEY, N. Y.—Representatives of the New York Central, Erie, Lehigh Valley, Buffalo, Rochester & Pittsburg, Pennsylvania and the Dansville & Mount Morris railroads held a conference in Rochester recently concerning a projected belt line to include a number of towns to the south of that city. The route as laid out would take in all of the railroads named. Electric trains of two or three cars would be run hourly, the round trip to take four hours. If it is found impossible to provide electric power it is suggested that second-hand engines from the Manhattan Elevated be bought. The proposed route is nearly one hundred miles in length, and takes in the principal towns of the Genesee valley.

NEW POWER-HOUSE AT LAFAYETTE, IND.—The Lafayette street car lines, which are a part of the Ft. Wayne & Wabash Valley Traction Company's system, are to have a new power plant which will cost $200,000. The new power plant will be built on the site of the plant now in use, and will be constructed with a view to serving interurban lines with power. The interurban line of the Ft. Wayne & Wabash Valley Traction Company is now building from Logansport to Lafayette. An extension from there to Attica, Williamsport, and eventually to Danville, Ill., is also proposed. It is understood that connections at Danville will be made with the McKinley syndicate, which proposes to build a through line from Illinois across Indiana into Ohio. The eastern terminal will be Lima, Ohio, and the western Champaign, Ill.

CLEVELAND & SOUTHWESTERN TRACTION COMPANY ACQUIRES BRANCH OF THE B. & O.—It is unofficially announced that the Baltimore & Ohio has decided on the abandonment of that part of the Lodi branch of the road, running from Wooster to Millersburg, and that the line has been secured by the Cleveland & Southwestern for use as a traction line. The portion reported to have been purchased by the Traction company is nineteen miles in length. The line from Wooster south to Millersburg will be a valuable acquisition for the Traction company, which now runs its cars from Cleveland to Wooster. It is endeavoring to extend its service in the direction of Zanesville. By entering Millersburg over the Lodi branch it will be in a direct line to Zanesville, through Coshocton. The territory in that portion of the state is free from electrical competition and the Southwestern would have a clear field.

EQUIPMENT FOR THE SYRACUSE & SOUTH BAY RAILROAD—The Syracuse & South Bay Railroad Company is planning to have an electric locomotive, similar to, but smaller than, those built by the General Electric Company for the New York Central & Hudson River Railroad, to handle the freight on the electric railroad between Syracuse and Oneida Lake, N. Y., as well as to haul passenger trains of eight or ten passenger cars whenever the traffic demands it. The company is now receiving estimates for its rolling stock. This will include twenty fifty-foot passenger cars and an equal number of trailers, which will be similar to the passenger cars, except that they will not be equipped with motors. In addition to the passenger cars, ten freight cars will be purchased. It is estimated that the rolling stock will cost approximately $150,000. One and possibly two boats, for operation on Oneida lake, will be built this winter.

SIERRA NEVADA POWER IN SAN FRANCISCO—On January 1, 1906, the electric street car lines, and probably the cable cars of the United railroads in San Francisco will be operated with electric power generated in the Sierra Nevadas. The power will be generated by the California Gas and Electric Company, which has made a contract with the railroad company to supply all of the electric power required for the operation of the street railroads for a period of twenty years from January 1, 1906. The supply is to be obtained from the "long-distance transmission lines" extended from the Sierras to San Francisco. In order to take care of any possible interruption of service from the long-distance transmission lines the California Gas and Electric corporation will install in San

Francisco a gas-making plant. The gas will be used for the purpose of operating gas engines direct-connected to electric generators. The order for these engines has been placed, and the first installation will be three engines and dynamos of 4,000-kilowatt capacity each, making a total installation of 16,000 horse-power at San Francisco.

NEW TELEPHONE EXCHANGE IN CINCINNATI—The new telephone exchange at the southeast corner of Canal and Race streets was opened last week. This exchange is one of the finest in the country. The building cost $60,000. The third floor of the structure is devoted entirely to the operating room. There are lounging rooms on the second floor for the operators, and everything has been provided for their comfort. The ground floor contains a storeroom for telephone appliances and also a schoolroom equipped with switchboard to instruct new operators. The switchboard in the exchange cost $100,000, and is the largest type used by the Bell Telephone Company. The operating room is so arranged that another switchboard of the same capacity can be installed there. The ultimate capacity of the exchange is for 9,600 subscribers, and 1,500 trunk lines will enter the operating room. It was necessary in setting up the new switchboard to solder 30,772,043 connections. The new manager of this exchange will be George C. Kappes, who is now the night manager at the main exchange.

ELECTRICAL NOTES FROM MEXICO—The Mexican Electrical Tramways Company, Limited, secured the right of way some time ago for the construction of a double track to Churubusco. The company has three years in which to complete the double track to Churubusco. The work of laying the double track will be commenced at once, and it will be completed early in 1905. The company is to immediately electrify the mule line from Tacuba to Atzcapotzalco. All the necessary formalities have been complied with by the company, and the work will be begun at once. It is announced that a concession for the utilization of 7,000 litres of water per second of the Angulo or Zacapu river, in the state of Michoacan, for motive power, has been granted. Among the provisions of the concession there is one whereby Mr. Brunel is authorized to import free of custom-house duties all apparatus, machinery and tools, etc., which he may need for his power plant. Application has been made to the David Reyes Retana for a concession to erect the works requisite to use 60,000 litres of water from the Mescala or Balsas river, in the state of Guerrero, for irrigation and hydraulic power, from a point where the Poliutla river enters to another point fifty kilometres distant.

PLAN TO REORGANIZE THE NEW HAMPSHIRE TRACTION COMPANY—The New Hampshire Traction Company, which operates a number of lines throughout southeastern New Hampshire and which extend into Massachusetts, is being reorganized. A reorganization committee consisting of Charles F. Ayers, of Boston, and Alfred B. Foster and Otto T. Barnard, of New York, have submitted a plan which provides for a foreclosure and the formation of a new corporation with $4,000,000 four per cent non-cumulative preferred stock and $4,000,000 common stock. Bondholders are to receive fifty per cent of the par value of principal on their bonds in new preferred stock and fifty per cent in new common stock, while holders of the certificates of indebtedness will receive new common stock to the par value of their certificates. Holders of a majority of the bonds have assented to the plan of reorganization. The New Hampshire Traction Company was organized two years ago by the New York Security Trust Company to consolidate the so-called Lovell system of railroads in southeastern New Hampshire. Unsatisfactory weather conditions seriously affected it from the time of its organization, and last November the company was obliged to fund two years' coupons upon its $7,500,000 bonds into certificates of indebtedness. Last winter the company sustained heavy losses.

REDUCTION OF CAPITALIZATION OF THE NEW ORLEANS RAILWAYS COMPANY—The New Orleans Railways Company is making a reduction of $20,000,000 in its total capitalization, bringing the figures down from $80,000,000 to $60,000,000. When this is done steps will be taken by the state looking to the dismissal of the suit now pending in the civil district court to enjoin that corporation from doing business in Louisiana. The Railways Company was organized under the laws of New Jersey to operate the various street railway lines in New Orleans, the company acquiring the property of the old New Orleans Traction Company and also taking over the Carrollton company's lines and those of the St. Charles street company and acquiring besides the Edison Electric Light Company and the New Orleans Gas Company. The company was capitalized at $80,000,000, of which $40,000,000 was represented by bonds, $10,000,000 by preferred stock and $30,000,000 by common stock. The fact that the capitalization has remained at $80,000,000 has been a source of constant annoyance to the company. It has helped to make sentiment adverse to it in strikes, and it was taken as the basis for large increases in the assessments of the company. At the same time it tended to make the company unstable and constantly open to attack. Louisiana laws prohibit over-capitalization, and some months ago the attorney-general and Mr. Omer Villere brought suit against the company, challenging its right to do business in Louisiana.

AUTOMOBILE NOTE.

ELECTION OF OFFICERS AT THE AUTOMOBILE CLUB OF AMERICA—The following officers of the Automobile Club of America have been elected for the year 1904-1905: president, Dave H. Morris; first vice-president, Colgate Hoyt; second vice-president, William K. Vanderbilt, Jr.; third vice-president, Clarence Gray Dinsmore; treasurer, Samuel H. Valentine. Three governors to serve three years, class of 1907: James L. Breese, Melville D. Chapman and Harlan W. Whipple. The annual banquet of the Automobile Club of America will be held at the Waldorf-Astoria on Saturday evening, January 21, 1905, the closing night of the Automobile Show.

ENGINEERING SOCIETIES.

CINCINNATI BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The Cincinnati branch of the American Institute of Electrical Engineers, by official invitation of the board of directors of the University of Cincinnati, was represented at the recent inauguration of Dr. Charles William Dabney as president. The committee consisted of the chairman of the local branch, Mr. B. A. Behrend; the secretary, Mr. Louis G. Bogen, and Messrs. D. Hall and C. S. Reno. Official recognition of the local chapters of the American Institute of Electrical Engineers is of considerable importance, as thereby their sphere of utility is enlarged and they become factors among scientific engineering societies.

THE OHIO STATE UNIVERSITY BRANCH, A. I. E. E.—The Ohio State University branch of the American Institute of Electrical Engineers held its second meeting for the year at the Electrical Engineering building on November 16. An interesting paper was read by William K. Liggett of the New American Elevator Company, of Columbus, upon "Automatic Electric Elevators." Mr. Liggett described the various devices by which automatic action was accomplished, calling attention to those features which were common to the different systems and those which were peculiar to each. He also explained the special difficulties encountered in this line of work. A discussion followed in which Mr. Liggett answered many questions with regard to the operation of the automatic and electric elevators in general. The next meeting will be held on December 7 at the same place.

PERSONAL MENTION.

MR. C. E. CHURCHILL has joined the staff of the Phelps Company, maker of the well-known "Hylo" incandescent lamps, Detroit, Mich.

MR. J. A. PAGE has assumed the local management of the Citizens' Telephone Company at Potterville, Mich. Mr. Page takes the place of Mr. John F. Collins, who has resigned.

SIR WILLIAM CROOKES has been awarded the Copley medal by the Royal Society of London for his long-continued researches in spectroscopic chemistry, on electrical and mechanical phenomena in highly rarefied gases, and on radioactive phenomena in other subjects.

MR. CHARLES N. WOOD, who for several years has been actively interested and a large owner in the Frank Ridlon Company, of Boston, has organized the Charles N. Wood Electric Company, 246 Summer street, Boston. This company will deal in dynamos and motors, and in repairing and rewinding electrical machinery. Mr. P. J. Murphy, who was formerly associated with Mr. Wood

and is quite well known in the electrical industry of New England, has joined forces with Mr. Wood, and the new house will begin business under the most promising auspices.

PROFESSOR ERNEST RUTHERFORD, of McGill University, Montreal, Canada, has been awarded the Rumford medal by the Royal Society of London, for his researches in radioactivity and for his discovery of the existence and properties of the gases emanating from radioactive bodies.

MR. CLARENCE D. CLARK has been appointed division superintendent of the California Gas and Electric Company, with headquarters at Napa, Cal. The section over which he has supervision is known as the Tower division. This includes the counties of Contra Costa, Napa, Sonoma and Marin.

MR. HAROLD FULWIDER, Denver, Col., has been elected president of the Electrical Engineering Society of the University of Colorado. The members of this society are student members of the American Institute of Electrical Engineers. The society was organized by Dean Henry B. Dates. The secretary is Alvin J. Forbess.

MR. THOMAS A. EDISON, it is announced in despatches from Berlin, is associated with the Bergmann Electrical Works, of Berlin, and the Deutsche Bank, also of Berlin, in the establishing of a large electrical company. It is understood that the works will be located in Germany, and that Mr. Edison will be a member of the board of directors.

MR. W. B. ESSON has commenced practising as a consulting engineer at 1 Victoria street, Westminster, London, England. Mr. Esson has for twenty years been occupying the post of chief engineer and manager to leading electrical firms abroad. His extensive experience will now be available for all matters connected with electrical undertakings.

DR. LOUIS DUNCAN has become associated with the staff of the Allis-Chalmers Company, Milwaukee, Wis. Dr. Duncan has been retained as an expert in electrical patent work in connection with the electrical department, the Bullock Electric Manufacturing Company, Cincinnati, Ohio. This connection has been made possible by the recent retirement of Dr. Duncan from the chair of electrical engineering at the Massachusetts Institute of Technology. Dr. Duncan will continue to make his headquarters at 56 Pine street, New York city, where he will be in close touch with the legal and executive offices of the Allis-Chalmers Company.

MR. O. L. REMINGTON, of the firm of William McLean & Company, Melbourne, Australia, left the United States last week for a trip through England and the Continent. It is his intention to be in New York about December 21 for a few days on his way back to Australia. Mr. Remington is open to negotiations with manufacturers desiring an Australian connection. William McLean & Company handle exclusively in Australia the products of the Bullock Electric Manufacturing Company, Cincinnati, Ohio; the Wagner Electric Manufacturing Company, St. Louis, Mo.; the Columbia Incandescent Lamp Company, St. Louis, Mo., and the Robbins & Myers Company, Springfield, Ohio. His New York address will be in care of the Astor House.

ELECTRICAL SECURITIES.

Despite the holiday and the irregularity in the movement of securities during the week ending November 26, a firm undertone was maintained, with sentiment possibly a little more evenly divided than has been the case for some months. There are a good many operators who apprehend a reaction at almost any moment. A reaction at this time would not be surprising, when it is remembered that the upward swing of security prices has been in progress since last March. Since that time there has been no serious, nor practically even temporary, interruption. A feature of the conditions since last June has been the ease with which money could be secured, and this has been largely responsible for the speculative boom which has taken place. A little hardening of money—which, by the way, seemed about to become a reality early in the week—would stem the tide of reckless buying. If, however, there was a halt in the activity of the stock market, it would not indicate that any serious retrogression was due, as it is possible that the market at this time has largely discounted the trade improvement, considerable as this has been. It would not be a bad idea, in fact, to mark time for a short period, so that things could come to a more nearly normal state.

During the week under consideration the steel stocks were the characteristic features of the market. In fact, it is plainly hinted in many quarters that if it had not been for the strength of these securities prices would have suffered a more serious decline. The apparent reason for the activity of the steel securities is the announcement that orders are once again in excess of the product, and that there has been, in fact, an effort made to buy some material abroad. Advances in pig iron have been made, and there have been intimations that further advances for finished products will be an early development. Complaints of car shortages speak for the improved condition in the transportation industry. This shortage, however, may be the result of the retrenchments which many railroad companies inaugurated some time ago. The fact, however, that the transportation business is feeling the necessity of greater service reflects the general improvement of industrial conditions at large.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 26.

New York:	*Closing.*
Brooklyn Rapid Transit	68
Consolidated Gas	215
General Electric	192⅞
Interborough Rapid Transit	169
Kings County Electric	202
Manhattan Elevated	167¾
Metropolitan Street Railway	122⅜
New York & New Jersey Telephone	160
Westinghouse Manufacturing Company	198

The annual stockholders' meeting of the Metropolitan Street Railway Company will be held December 5, at 12 M.

To anticipate by a year the date when the absolute guarantee of 7 per cent on Manhattan Railway Company stock takes effect, the Interborough Rapid Transit Company has agreed to pay on January 1 a dividend of three-quarters of 1 per cent on Manhattan stock, in addition to the regular dividend of 1½ per cent. Thereafter 1¾ per cent will be paid quarterly on the stock.

At a special meeting of the stockholders of the Commercial Cable Company, held November 22, it was unanimously decided to amend the company's certificate of incorporation. The company now has power to dispose of and purchase the stocks and bonds of any foreign or domestic corporation. The company also has power to lease or sell its property and franchises to any telephone or telegraph corporation.

Boston:	*Closing.*
American Telephone and Telegraph	145¾
Edison Electric Illuminating	248
Massachusetts Electric	62
New England Telephone	134
Western Telephone and Telegraph preferred	100

Philadelphia:	*Closing.*
Electric Company of America	10⅞
Electric Storage Battery common	83½
Electric Storage Battery preferred	83½
Philadelphia Electric	8
Philadelphia Rapid Transit	18¼
United Gas Improvement	104⅛

Chicago:	*Closing.*
Chicago Telephone	142
Chicago Edison Light	168
Metropolitan Elevated preferred	67
National Carbon common	45½
National Carbon preferred	109¾
Union Traction common	13½
Union Traction preferred	45

The directors of the South Side Elevated Railroad have declared the regular quarterly dividend of 1 per cent on the capital stock, payable December 31. Books close December 21 and reopen January 1.

TELEPHONE AND TELEGRAPH.

PIERCE, NEB.—Daniel Duff has been granted a telephone franchise.

MOBILE, ALA.—The line of the Eastern Shore Telephone to Mobile is now in operation.

GARDEN, OHIO—The Enterprise Telephone Company is rebuilding its lines at this place.

DELANO, MINN.—A telephone line will be built through this place from Watertown to Lynndale.

WORCESTER, MASS.—A new switchboard has been installed at the Millbury central exchange.

EDINA, MO.—The Barnett Telephone Company will probably build a line from this place to Baring.

OAKDALE, IOWA—Thomas Heyland will build a line to connect with the Cedar Valley telephone line.

NORTH NEWARK, N. J.—The telephone company is extending its line to connect with the line at Caroline.

IOWA FALLS, IOWA—A new telephone company has asked for a franchise to build a local exchange here.

NEWARK, N. J.—The People's Rural Telephone Company has over 100 subscribers to start with at Woodstown.

DOYLESTOWN, PA.—It is proposed to erect a telephone system along the Philadelphia and Easton trolley at once.

STERLING, ILL.—The Deer Grove Mutual Telephone Company is at work on a line from Hahnaman to Deer Grove.

TROY, N. Y.—The Hudson River Telephone Company is planning to install a new telephone system in Poughkeepsie.

PLAINFIELD, N. J.—The Farmers and Merchants' Telephone Company will extend its line to Cokesbury, Hunterdon County.

WEST DE PERE, WIS.—The Wisconsin Telephone Company will build a line from this place to Rockland in the near future.

CAWKER CITY, KAN.—The Limestone Farmers' Telephone Company will build several new lines. E. M. Dietz is president and manager.

SALT LAKE CITY, UTAH—Work is to commence at once on rebuilding the telegraph line from Milford to Uvada along the Salt Lake route.

EASTON, PA.—The Lehigh Telephone Company will install a twenty-line branch exchange switchboard in the new Allentown National Bank Building.

GOSHEN, IND.—The Bell Telephone Company is putting in a second toll line from here to Ligonier and establishing a toll station at that place.

ERIE, PA.—Lawrence County farmers have organized a telephone company which, it is said, is to be the beginning of a rural system covering western Pennsylvania.

EUGENE, ORE.—The Eugene-Florence-Elmira Telephone Company is constructing a line from this city to the mouth of the Siuslaw river, a distance of eighty miles.

MARION, IND.—The Bell Telephone Company is making some extensive improvements in Grant County and is now extending its lines from Marion through to Huntington.

CULLMAN, ALA.—Walter Cable has sold for $2,000 his half interest in the Cullman telephone system to S. L. Sherrill, of Hartselle, who owns the other half interest.

CREWE, VA.—It is stated that the rural line being built through Nottoway and adjoining counties will come into Crewe and connect at the present central office with the local line.

LOGANSPORT, IND.—The Independent telephone system at Bunker Hill has been sold to the Bell Telephone Company. The plant was installed two years ago, and has done a large business.

FROST, IOWA—The Erhdahl Telephone Company has recently elected officers as follows: M. R. Erhdahl, president; C. C. Erhdahl, vice-president; O. J. Nelson, secretary; S. L. Hovland, treasurer.

OSAGE CITY, KAN.—A local telephone company has been organized here and officers organized as follows: president, William Sanders; secretary, Luther Anderson; treasurer, O. M. Johnson.

RACINE, WIS.—The directors of the Citizens' Telephone Company at a meeting decided to expend $30,000 for the erection and thorough equipment of a modern central station. The company has 2,000 subscribers.

LEWISTON, ME.—The Northeastern Telephone Company is considering the question of building a spur from its main line at Turner Centre to Keen's Mills. A franchise has been granted the company to do business in Bangor.

COUNCIL BLUFFS, IOWA—The Independent Telephone Company, of Council Bluffs, has filed articles of incorporation in the county recorder's office and also placed its application for a franchise on file in the city clerk's office.

NEWARK, N. J.—The Farmers and Merchants' Telephone Company is arranging to extend its line from Annandale to Cokesbury. This telephone company is entirely local and will connect every town and hamlet in Hunterdon County.

NEWARK, N. J.—The Chester local telephone company has about forty subscribers and is making preparations to extend the service into suburban territory. Alonzo P. Green is president, and George E. Conover secretary and treasurer.

BARTON, N. Y.—The Ross Hill-Barton Independent Telephone Company at a recent meeting transacted all preliminary business and appointed a construction committee. The company is now in readiness to begin construction work immediately.

BLOOMINGTON, NEB.—A new telephone company has been organized in this city and will build lines to Kensington, Agra and other surrounding towns. The officers are: Frank Donovan, president; J. B. McCullough, treasurer; S. Horn, secretary.

ALVIN, TEX.—The Southwestern Telegraph and Telephone Company has purchased the Alvin & Angleton Telephone Company, including the local exchange at this place. The Southwestern will at once put in a more complete system and make other needed improvements.

BUFFALO, N. Y.—Announcement is made of the merger of the Oneonta Independent Telephone Company with the Central New York (Bell) Company. Through this move all the telephone service in Oneonta and the towns in that section passes into the hands of the Bell company.

DUNDEE, N. Y.—At the recent annual meeting of the Tyrone Telephone Company the following directors were chosen: Philander LaFever and Monroe Sutton, Dundee; Eugene Bigelow, Charles Losey, Altay; Charles Shaffer, D. S. Crawford, S. Alden Van Liew, Tyrone; and Stephen Switzer, Bradford.

STITTVILLE, N. Y.—The Stittville & Camroden Rural Telephone Company has been organized and has elected the following officers: C. H. Evans, president; Robert Charles, vice-president; O. E. Jones, secretary; John Evans, treasurer; trustees, Hugh W. Roberts, J. B. Jones and G. W. Jones; general manager, Ellis D. Jones.

WASHINGTON, GA.—Arrangements have been completed whereby the Washington Telephone Company will connect all parts of Wilkes County. The local exchange has just finished putting in cables on the principal streets and the installation of an entire new system. It has also connected with the Southern Bell Telephone and Telegraph Company.

OMAHA, NEB.—Additional cables, costing about $35,000, are being laid by the Nebraska Telephone Company, the lines running to the residence district of the city. The company has been canvassing for new subscribers at the reduced rates, which go into effect on January 1, and it is for the accommodation of these that the new lines are being laid.

PITTSTON, PA.—The Hollenback Telephone Company will begin work on the construction of a line that will run between Wapwallopen, Hobbie, Dorrance, Pond Hill and other places in that vicinity. The company is made up of citizens living along the line, M. W. Bittenbender being the president. The office of the company will be at Wapwallopen.

HONESDALE, PA.—The Stroudsburg & Bushkill Telephone Company has made a survey to Portland and will extend its line to that place and there connect with the Slate Belt company's lines, also with the lines running to many towns in New Jersey and New York. The material for the extension has been ordered and the construction will be commenced at once and pushed to completion with all possible speed.

TROY, N. Y.—The Western Union Telegraph Company has notified the city that it has decided to place all its wires in the business part of the city underground. This action was taken at a meeting of the directors held recently in New York. Work on the construction of the conduits will soon be begun. The Postal Telegraph Company has already placed its wires underground in the central part of the city.

LYNCHBURG, VA.—A force of workmen is at work near Danville on the erection of two new long-distance telephone lines between Danville and this city. These new circuits will be constructed of No. 12 copper wire and will add considerably to the service between the two cities. The only line that connects Lynchburg and Danville now is a single line, on which all of the long-distance business, as well as considerable local work, is done at intermediate stations.

CONNELLSVILLE, PA.—Work has been started on a through wire for the Tri-State Telephone Company between the Connellsville office and Baltimore. With its completion the Tri-State will have its first through connection from Pittsburg to the East. The company now has western Pennsylvania thoroughly covered. The whole of this winter will be required to build the Baltimore line. All the intermediate towns and cities, of course, will be tapped on the through trunk line.

JERSEYVILLE, ILL.—The Jerseyville city council at a special meeting granted a franchise to the Kinloch Long-Distance Telephone Company of Missouri to construct a line through the city and to establish eight toll stations. The Kinloch company has already constructed a line from Alton to the Jerseyville city limits. The Kinloch line will join the Illinois Telephone Company's line north of Jerseyville. As soon as the line in Jerseyville is completed it is stated that long-distance lines will be built to Grafton and into Calhoun County, to be united with the independent lines in that section.

SOUTH BEND, IND.—As a result of a conference between several officers of the Central Union Telephone Company some important changes will be made in the local equipment of the company which will greatly improve the service. The improvements will cost several thousand dollars and work will begin at once. Among the improvements will be the installation of 32,000 feet of cable in addition to the underground cable now being placed in position to take care of the outlying districts, the present system not being of sufficient capacity to accommodate the rapidly increasing business.

MARION, IND.—John Golding, who is also principal stockholder in the Sims Telephone Company, has sold his franchise in Converse to the Amboy Home Telephone Company. The franchise through the streets and alleys of Converse, which is for fifty years, was granted Mr. Golding May 29, 1902. It has since been used by the Greentown company. The Amboy, Sims and Greentown plants are independent, and do not have connection with the Bell system here. W. H. Myers, manager of the Amboy company, states that connection will be made with Converse at once; also that a switchboard will probably be placed here next spring.

BINGHAMTON, N. Y.—Arrangements are being made by the Independent Telephone Company to construct a telephone exchange at Oxford from which two wires will be strung to Greene, connecting at that point with the Chenango Valley company, which in turn will connect with the York State company at Chenango Bridge, thus bringing this city into direct communication with these places over the York State lines. In addition to this, plans have been formed for the establishment at Endicott of a telephone exchange to serve about seventy-five patrons at both Union and Endicott with all-day, all-night and Sunday service.

ELECTRIC LIGHTING.

JOPLIN, MO.—The light plant, owned by the city, has been destroyed by fire.

BEAR LAKE, MICH.—Work is being pushed on the new electric lighting plant at St. Ignace.

SOUTH BOARDMAN, MICH.—There is a prospect of an electric light plant being established here.

MONTREAL, QUEBEC—Estimates are being prepared for an electric lighting plant at Charlottetown.

SANDERSVILLE, GA.—The new electric light plant and waterworks system have been placed in operation.

WILKESBARRE, PA.—The Shawnee Electric Light Company has been granted a franchise in Edwardsville.

WARWICK, N. Y.—The citizens of Monroe are considering the matter of installing a municipal electric plant.

CARBONDALE, PA.—The ordinance granting the Lackawanna Valley company a contract for street lighting for three years has been passed.

WAVERLY, IOWA—At an adjourned meeting of the city council of Waverly the Healy electric light plant was purchased. The price paid was $13,500.

SAYVILLE, N. Y.—The Sayville Electric Light and Power Company will install a new dynamo and engine. This will necessitate the enlargement of the present building.

ST. JOSEPH, MO.—The contract for building the new powerhouse for the municipal electric street-lighting plant has been awarded by the board of public works to Warner Bros. at their bid of $13,291.

SARNIA, ONT.—The Wallaceburg Electric Light Company has been reorganized. The new officials are as follows: W. D. McRae, president; D. C. McDonald, vice-president; Hugh C. Stonehouse, secretary-treasurer.

PLATTSMOUTH, NEB.—The Plattsmouth gas and electric light plant has been sold to the Nebraska Lighting Company, Charles C. Parmele, president. The company has filed articles of incorporation in the sum of $100,000.

AZUSA, CAL.—At a recent meeting negotiations were concluded whereby the city of Azusa purchased from the Azusa Electric Lighting and Power Company the local plant, the compensation being $2,300.

DAVENPORT, IOWA—The Black Hawk Electric Company has been awarded the contract for the installation of an electric plant at Searcy, Ark. The work is to be completed March 1, and will involve an expenditure of $20,000.

CLIFTON SPRINGS, N. Y.—The contract for the building of the electric light plant has been let to R. Morphy and A. Barry. The work has been commenced and will be pushed. Nearly all the poles for the system have been received here.

EASTON, PA.—The Monroe County Water Company has been granted a franchise to plant its poles and erect wires on the streets of Stroudsburg. It is the intention of the company to furnish electrical power to the various industrial plants of that borough.

ANADARKO, OKLA.—The city council of Anadarko has decided to build a municipal lighting plant, and has employed an engineer to furnish estimates and plans. It is the intention of the council to operate the lighting system in connection with the waterworks system. The waterworks will be in operation within sixty days, and the council expects to be able to light the city within ninety days.

LINCOLN, NEB.—The Middle Loup Electric Power Company proposes to construct an electric power plant at Comstock, Custer County, and will spend more than $35,000 in equipping a water power on the Middle Loup river. An application to construct a dam across the river, to cost $25,000, and a race to cost $10,000, has been filed with the secretary of the state board of irrigation by John Dierks on behalf of the proposed power company. The plant will be one of the largest electric power plants in the state and it is proposed to distribute power to the towns of the vicinity.

NEW INCORPORATIONS.

NILES, MICH.—Niles & Buchanan Railway Company. $25,000.

NEW HAMPTON, N. H.—Winona Telephone Company. $2,500.

JERSEY CITY, N. J.—Monterey Water, Sewer and Power Company. $4,000,000.

OXFORD, N. Y.—Oxford Valley Telephone Company. Increased from $1,000 to $5,000.

NORWALK, IOWA—Middle Branch Telephone Company. $1,200. Incorporators: W. A. Cotinam and others.

PORTLAND, ME.—L. C. Smith Transit Company. $250,000. Incorporators: M. W. Baldwin and G. I. Knight.

MADISON, WIS.—The White Oak Telephone Company, of White Oak Springs. $2,500. Incorporators: H. A. Beckwith, Joseph Edge.

SPRING VALLEY, ILL.—Spring Valley Lighting and Power Company. Incorporators: John McFadden, Reinhold Reichardt, Harry E. Brown.

MORRISON, ILL.—Rock River Hydroelectro Milling and Power Company. $50,000. Incorporators: George A. Whitcomb, Edward A. Smith, Harvey S. Green.

TRENTON, N. J.—The Inca Company. To operate electric plants, etc. $150,000. Incorporators: Felix Emmannelli, Alexander T. Garbe, Henry A. Bingham.

JERSEY CITY, N. J.—Public Survey Company, of St. Cloud, Minn. $125,000. Incorporators: R. L. Gale, C. L. Campbell, E. E. Clarke, all of St. Cloud, Minn.

COLUMBUS, OHIO—The Cuyahoga Light and Power Company. $25,000. Incorporators: A. Lowenthal, E. Umstetler, C. L. Denton, H. J. Caldwell and M. W. Little.

HOUSTON, TEX.—Elmira & Eastern Transportation Company. $10,000. Incorporators: Thomas S. Foster, M. L. Womack, of Houston, and W. B. Clint, of Elmira.

MONTGOMERY, ALA.—The Baldwin County Telephone Company. $6,000. Incorporators: Aaron Moog, R. A. Hall, John Miller, John H. Cross and V. M. R. Schowalter.

PORTLAND, ME.—Grand Rapids-Muskegon Water Power Company. $1,000,000. President, J. G. Emery, Jr., Muskegon, Mich.; treasurer, D. D. Erwin, Muskegon, Mich.

ESTHERVILLE, IOWA—Emmett County Telephone Company. $50,000. President, I. O. Isham; vice-president, M. B. Miller; secretary, A. J. Sanders; treasurer, J. B. Binford.

LANSING, MICH.—The Incandescent Light and Power Company. $600,000. Incorporators: Sherman R. Miller and George H. Paine, of Detroit, and Joseph Stubbers, of Cincinnati.

COLUMBUS, OHIO—The Citizens' Heat, Light and Power Company. Incorporators: Anthony Howells, William L. Davis, Austin C. Brant, Winfield S. Shirtzer, Harry H. Miller, William R. Zollinger.

MOUNT OLIVE, N. C.—Mount Olive Light and Power Company. $100,000. Incorporators: X. T. Keel, William Maxwell, J. W. Williamson, J. A. Smith, M. T. Breazeale, D. B. English, L. P. Aaron and J. W. Keel.

BALTIMORE, MD.—United Telephone and Telegraph Company. $10,000. Directors: V. Smith, J. H. Stoner, M. E. Sollenberger, W. H. Gelbach, I. E. Yost, Jeremiah Zullinger, J. M. Newcomer, D. M. Wertz, V. B. Good and Samuel Dreyfuss.

PORTLAND, ME.—Commonwealth Power Company. $4,000,000. President, W. A. Foote, Jackson, Mich.; treasurer, G. W. Ritchie, Kalamazoo, Mich.; clerk, W. M. Bradley, Portland, Me.; directors as above named, and E. P. Robertson, Albion, Mich.; E. C. Nichols and G. W. Mechem, Battle Creek, Mich.

ELECTRIC RAILWAYS.

MOORHEAD, N. D.—A franchise has been granted for an electric railway.

SPRINGFIELD, OHIO—On December 23 the Xenia & Springfield traction line will be again offered for sale.

OAKLAND, CAL.—The Oakland Traction Company has secured the franchise to build an electric road along College avenue.

CLAYTON, N. J.—New York capitalists are said to be interested in the construction of an electric line from Woodbury to Vineland, to pass through Clayton.

LOS ANGELES, CAL.—Signal Hill Improvement Company, of Long Beach, has completed surveys for an electric road from Long Beach to the top of Signal Hill.

SPOKANE, WASH.—The engineers of the Spokane Power and Transportation Company surveyed the proposed line from Crystal City to Mondovi, a distance of thirty-seven miles.

MIDDLETOWN, PA.—The Philadelphia, Lancaster & Harrisburg Electric Railway Company, the backers of which are Edgar A. Tennis and Drexel bank of Philadelphia, will build a trolley line to connect with its road at Coatesville.

JACKSON, MICH.—A franchise has been granted to William A. Boland, of Grass Lake, and Worrall Wilson, of Jackson, to build an electric road through Leslie, said road to run through the main street of the town. The third-rail system will be used.

FAIRMONT, W. VA.—The Fairmont & Clarksburg Electric Railroad Company has concluded to extend its line from Middleton to Clarksburg at an early date. It is the intention of the company to start the work early next spring and push it to completion.

BOSTON, MASS.—The Middleboro, Wareham & Buzzard's Bay Street Railway will be sold at auction on December 7 at Middleboro, and the Bristol County Street Railway will be sold at Attleboro December 17. Both roads went into the hands of receivers last spring.

NEW YORK, N. Y.—A reorganization committee for the New Hampshire Traction Company has been formed, consisting of Otto T. Bannard, chairman, president of the New York Security and Trust Company, and Alfred D. Foster and Charles F. Ayer, of Boston.

LANGHORNE, PA.—Directors of the Feasterville and Richboro turnpike have sold five miles of the road, from the city line to Richboro, to Langhorne parties for $5,000. It will be used for the proposed trolley line from this town, through Trevose and Feasterville, to Somerton.

LATROBE, PA.—A charter has been granted to the Latrobe-Mt. Pleasant Street Railway Company. Its route will be by way of Pleasant Unity and will embrace Lycippus, Hostetter, Klondike and several other mining towns. Mt. Pleasant and Pittsburg promoters are the stockholders.

MURPHYSBORO, ILL.—The city government of Anna, Ill., has granted a franchise to the Union County Traction Company, and work will be commenced at once on a line to connect Anna and Jonesboro. The construction of a large electric light plant to supply both cities will also begin immediately.

GUTHRIE, O. T.—S. L. Nelson, of Fort Wayne, Ind., William McKintry, of Champaign, Ill., George Duncan and Edward Woodman, of Portland, Mo., are arranging for the construction of an electric interurban, which will connect Oklahoma City, Norman and Lexington, in Oklahoma, with Sulphur Springs, I. T.

PUTNAM, CT.—The Providence & Danielson Electric Railway Company intends to build a power-house at North Sterling, using water power instead of coal. The plan is to build a dam thirty-six feet high across the Quadic brook. From government surveys it is calculated that the reservoir will extend to Killingly, a distance of five miles.

NASHVILLE, TENN.—Charles E. Dyer, of Tullahoma, representing Chicago capitalists, has submitted a proposition to the people of Lynchburg and Moore County to the effect that he will build and equip an electric freight and passenger railway from

Tullahoma to Lynchburg if they will subscribe about $50,000 to the construction and equipment of the road. The distance is twelve to fourteen miles.

VINELAND, N. J.—Work has been completed on the survey of the proposed trolley extensions of the Camden, Gloucester & Woodbury Railway lines from Almonesson to Blackwood, and from Mantua to Mullica Hill. The right of way between the two latter towns has been obtained, and it is said work on the line will continue through the winter. The proposed route to Clayton through Pitman has been abandoned for the present.

CANTON, OHIO—Arthur Wright, C. L. Morgan and G. R. Gyger, of this city, have qualified as directors of the Akron-Alliance Connecting Railway Company. The company some time ago secured a right of way between the two towns of Akron and Alliance and all the surveying was done, but actual work was never started. The company is now being reorganized and new men will be placed at the head of affairs in the hope of pushing the project through.

IOWA CITY, IOWA—An interurban line from Iowa City to Chicago is regarded here as practically certain. The Iowa part of the line from here to Davenport, through Tipton, was incorporated two weeks ago by Steven Bradley, Milton Remley, C. S. Ranck and other men of this city. The financial backers of the Davenport-Iowa City line are the same men who are planning the line from Rock Island to Dixon and who are operating the interurban from Dixon to DeKalb and DeKalb to Aurora.

HILL CITY, MINN.—It is reported here that the Duluth, Missabe & Northern Railway Company will build nine miles of spur tracks in the Hibbing mining district during the coming winter. It is understood that one of the spurs will connect the village of Chisholm with the main line, and that passenger service will be given that place. Connections will be made with several new properties now being developed by the Oliver Iron Mining Company of the United States Steel Corporation.

CHICAGO, ILL.—Evanston capitalists have formed a company to build an electric line from that city west to Golf, the station on the St. Paul railroad, near the Glen View golf grounds, and to build feeders to Niles Center and Grosse Point, a distance of twelve miles. The name of the new company is the Evanston Interurban. Work will begin in January, and it is expected the road will be in operation by the time the golf season opens. Trains are expected to run every twenty minutes each way.

PHILADELPHIA, PA.—The Bloomsburg & Millville Street Railway Company, with a capital of $60,000, has been chartered. The charter of the company gives it an existence of 999 years and the route is about ten miles in length. The officers of the company are: president, C. W. Miller; directors, L. E. Waller, C. C. Peacock, C. M. Creveling, James C. Brown and F. E. Miller. The road will be financed by E. W. Darlington, of Philadelphia, and construction will be started in the near future. All arrangements have been practically completed.

CINCINNATI, OHIO—At a meeting of the directors of the Toledo & Ohio River Railway Company it was reported that right of way valued at $200,000 had been secured to build a line from Galina, Ohio, to Ironton, and that the work would begin early in the spring, all the surveys having been made. The new line will be owned by the Cincinnati, Hamilton & Dayton Railway and will give that road an independent entrance into Ironton. At this meeting J. H. Bromwell was elected president; Walter S. Parks, vice-president, and F. M. Carter, secretary and treasurer.

AMHERST, MASS.—The annual meeting of the stockholders of the Amherst & Sunderland Street Railway Company was held recently. The following directors were chosen: Walter D. Cowls, Mason A. Dickinson, Theodore L. Paige, F. L. Whitmore, H. B. Edwards, C. F. Deuel, E. D. Marsh. The directors chose the following officers: president, W. D. Cowls; vice-president and treasurer, H. A. Dickinson; secretary, C. H. Edwards; superintendent, H. M. Aldrich; executive committee, W. D. Cowls, M. A. Dickinson, T. L. Paige. The gross receipts of the year have been $31,633.81; operating expenses, $28,451.01; net income, $3,182.80.

SILOAM SPRINGS, ARK.—The Siloam Springs Electric Railroad, Power and Improvement Company has been organized here with a capital stock of $500,000. The corporation is to build, equip and operate an electric railroad, commencing at Siloam Springs, to run up the Illinois river to a point about twelve miles due east from this city, near the junction of the Illinois and Osage rivers. The water of the Illinois river will be utilized to develop power to operate the electric dynamos. The available power is practically unlimited, certainly ample for all the needs of an extensive system of electric roads and the demands of a city of 25,000 people. Power for manufacturing and other plants can be profitably transmitted twenty-five or thirty miles.

MUNCIE, IND.—The preliminary survey for the Northwestern Ohio Traction Company's proposed line from Celina, Ohio, to Muncie has been completed and work on the road will soon begin. The road will run through Portland, Redkey, Dunkirk, Albany and at Celina will connect with the company's line to Lima, Wapakoneta and way stations. The Dayton & Muncie Traction line between Dayton, Ohio, and Muncie will be in complete operation by January 1, it is said. The wire has been strung and the rails laid within about three miles of this city, though the road is now only operating from Winchester eastward. It is officially announced that plans have been completed and most of the right of way obtained for the Indianapolis & Southwestern's road from Toledo, Ohio, to Indianapolis by way of Muncie.

STAFFORD SPRINGS, CT.—Preliminary surveys are being made for an ambitious street railway in this locality. The proposed line will run from Stafford Springs irregularly westward and will connect with the tracks of the Hartford & Springfield Street Railway Company, near the Massachusetts state boundary. The route is about twenty-seven miles long and it runs through a succession of villages lying in the northern part of Tolland and Hartford counties. It touches the Crystal Lake region, and, according to its promoters, would be likely to develop a large summer pleasure travel. For a considerable distance the contemplated trolley will run on private land. It is understood that options on needed rights of way have already been secured. The promoters of the enterprise will apply to the next session of the General Assembly for a franchise.

EDUCATIONAL.

THE WORCESTER POLYTECHNIC INSTITUTE—The November issue of the Journal of the Worcester Polytechnic Institute contains the interesting paper by Professor Harold B. Smith, entitled "Notes on Experiments with Transformers of Very High Potentials," which was read at the recent International Electrical Congress, and a contribution entitled "The Specific Heat of Superheated Steam," by Sidney A. Reeve.

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY—The Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., held founder's day exercises on Wednesday evening, November 30, at eight o'clock. The address was delivered by General William Sooy Smith, consulting engineer, Chicago, Ill. General Smith has had a large experience in engineering work with the United States Army, and later as civil engineer in the design of large bridges, subaqueous tunnels, lighthouses, etc.

LEGAL NOTE.

FOUR SUITS FOR INFRINGEMENT OF INCANDESCENT LAMP PATENTS—The General Electric Company has brought suit against the Jaeger Miniature Lamp Manufacturing Company, of New York city, and the American Endoscopic Company, of Providence, R. I., for infringement of an incandescent lamp on patent granted to Thomas A. Edison, No. 444,530, in which suits the Edison Electric Light Company is complainant. The General Electric Company is complainant in two suits which have been started against the Germania Electric Lamp Company, for infringement of patents granted to Spiller and Massey, No. 537,493, and Mark H. Branin, No. 532,760. The bills of complaint in these four suits were filed on November 22.

RECEIVERSHIP NOTE.

TRACTION COMPANY IN RECEIVER'S HANDS—It is reported from Lexington, Ky., that the Fayette circuit court has ordered the Blue Grass Consolidated Traction Company into the hands of a receiver, for the purpose of winding up its business affairs and disposing of its interests to satisfy claims and liabilities which are being pressed against the company. The corporation is owned and controlled by George B. Davis, of Detroit, Mich., and was originally incorporated for $7,000,000.

INDUSTRIAL ITEMS.

AUGUST MIETZ, 128 Mott street, New York city, manufacturer of the Mietz & Weiss oil and gas engine, has been awarded a gold medal and special diploma at the Louisiana Purchase Exposition for this engine.

THE CHARLES N. WOOD ELECTRIC COMPANY, 246 Summer street, Boston, Mass., has been established by Mr. Charles N. Wood, late of the Frank Ridlon Company, of Boston. The company will deal in dynamos and motors, and will undertake the repairing and rewinding of all classes of electrical machinery.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., is distributing bulletins Nos. 7030, 7035 and 7040. Bulletin No. 7030 describes multiple series, constant-current arc lamps for direct-current circuits. No. 7035 describes multiple, constant-potential-alternating-current arc lamps, and No. 7040 describes multiple, constant-potential, direct-current arc lamps.

GEORGE H. BUCKMINSTER & COMPANY announce that George H. Buckminster and Charles F. White have entered into a partnership for the purpose of conducting an electrical specialty business at 155 Milk street, Boston, Mass. The new firm will aim to give its customers careful, intelligent and prompt service, and to furnish them with electrical specialties of good quality at reasonable prices.

THE P. M. FLETCHER COMPANY has recently been formed by Mr. P. M. Fletcher, who for the past eleven years has been manager of the retail department of the Western Electric Company. The company will handle electrical supplies for contractors and isolated plants around New York, and has as its specialty the Shelby incandescent lamp. The company is located at 111 Chambers street, New York city.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., announces that its New England offices, which have been in the Board of Trade Building, Boston, Mass., and the offices of its electrical department—the Bullock Electric Manufacturing Company—in the Journal Building, Boston, were consolidated on December 1 and removed to the State Mutual Building, 50 Congress street. Mr. George H. Berg will be the manager in charge of the consolidated offices.

THE AMERICAN ELECTRIC SIGN COMPANY, 133 Summer street, Boston, Mass., is manufacturing electric signs which, it is claimed, reduce the number of lamps and the candle-power of the lamps to such an extent that a saving of over fifty per cent in the operating expenses is secured, at the same time producing brilliant lighting effects. The company has moved into its new factory in south Boston, and is working night and day to meet the demand for its production.

THE WILMINGTON FIBRE SPECIALTY COMPANY, 104 West Fourth street, Wilmington, Del., is manufacturing a complete line of hard fibre in sheets, tubes, rods and special forms. The company is prepared to promptly execute orders for hard fibre in a multitude of forms, for insulation or mechanical purposes. The company states that it is an independent manufacturer, unhampered by agreements, and can make attractive inducements to consumers of this class of goods.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, has equipped a very complete miniature lamp department in its lamp factory. The candelabra goods are equipped with the spiral filament, the same as in the "Sterling Special" lamps. The company has on hand a stock sufficiently large and varied to enable it to make prompt shipments on orders for all goods which it catalogues. The company is also in a position to manufacture, on special order, anything in the way of uncatalogued goods, such as lamp novelties.

THE A. S. CAMERON STEAM PUMP WORKS, foot East Twenty-third street, New York city, is distributing an illustrated pamphlet calling attention to its various forms of steam pumps. This pamphlet is a partial reproduction of its large catalogue, which has also been recently issued. It has not been attempted to present more than a few of the designs which the company builds. The company will be pleased to confer with prospective buyers through its representatives and agents with regard to pumping applications of any description.

THE ELECTRICAL STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently closed the following contracts for chloride accumulator installations: two three-wire batteries for the Union Electric Light and Power Company, St. Louis, Mo.; one three-wire battery and one exciter battery for the Edison Electric Illuminating Company, Boston, Mass.; one three-wire battery for the Rochester Railway and Light Company, Rochester, N. Y., and an increase in the capacity of the first battery installed for the Rochester Railway Company in November, 1898; an exciter battery for the Interborough Rapid Transit Company, New York city; a regulating battery for the Public Works Company, Bangor, Me.; a lighting and power battery for the New York Hall of Records, contracted for through the Charles L. Eidlitz Company, and residential and isolated lighting batteries for a number of installations in Maryland, Massachusetts, Virginia, New York, Pennsylvania, Illinois, Wisconsin, Iowa, and Hamilton, Ont.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, New York and Atlanta, manufacturer of the Allen-Bradley electric crane controller, announces that it is now prepared to execute orders for all sizes of electric controllers. The company has been busy during the past six months preparing for the market a number of new designs of controllers, and at this time, besides the present line of well-known Allen-Bradley crane controllers, orders are being filled for controllers for all purposes. The company makes a liberal offer to all customers purchasing Allen-Bradley controllers. The proposition includes a three months' trial, with the privilege of returning the goods if not satisfactory, and one year's guarantee against any repairs. It is understood that, although a large number of controllers have been sold by the company, there has not been returned as unsatisfactory a single machine. By January 1 the company will have a complete line of rheostats of all types. These rheostats will be sold under the same guarantee as the crane controllers. The business of the company has been very prosperous, and the factory equipment has been more than doubled during the past three months.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is sending out circulars to the trade, calling attention to the preparations it has made to supply from Chicago stock Christmas tree lighting outfits. The figures the company is able to quote on this material are unusually attractive. The outfit contains twenty-seven lamps of two candle-power. The bulbs are in assorted colors—red, green, blue, frosted, canary and amber. There are twenty-four sockets and twenty-seven lamps, the three extras being included in case of breakage. Fifty feet of lamp cord is also included. The attachment plugs are made for either Edison or Thomson-Houston base, as specified. Each socket has three strands of eight lamps each. The entire outfit will cover a space fifteen by eighteen feet, and will furnish sufficient illumination to light a room thirty by thirty feet, with a twelve-foot ceiling. The company is enthusiastic over the outlook for trade in this particular line, and also reports a gratifying trade on portable lamps, electric chafing-dishes, toy electric railways and other holiday specialties.

THE CHASE-SHAWMUT COMPANY, Newburyport, Mass., will be pleased to mail bulletin No. 28, covering Shawmut National Electrical Code standard enclosed fuses. These fuses are designed and made to conform to the latest specifications of the National Board of Fire Underwriters. These specifications call for the product of the different manufacturers of this material to be interchangeable—that is, fuses of a given class must be so constructed that it will be possible to use them in any other manufacturer's cutouts. These cutouts are also made to conform to the National Electrical Code standard. The Chase-Shawmut Company has been working on this material for quite a long period. It is now able to announce that a complete line is in stock for immediate delivery. The company has been aided in its efforts in this direction from the fact that, in selecting dimensions for the National Electrical Code standard fuses, two of the standards selected conformed to its regular line of material, enabling the company to save a complete line of porcelain in both the thirty and sixty-ampere, 250-volt sizes.